



NBS TECHNICAL NOTE 829

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

Multicommodity Network Plotting via Program NETPLT

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Multicommodity Network Plotting via Program NETPLT

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t. Technical note no. 827

Sponsored by the
Defense Communications Agency
Director, DCEC, Attention R-150
1860 Wiehle Avenue
Reston, Virginia 22090



U.S. DEPARTMENT OF COMMERCE, Frederick B. Dent, *Secretary*
NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, *Director*

Issued June 1974

Library of Congress Catalog Card Number: 74-6000 74

National Bureau of Standards Technical Note 829

Nat. Bur. Stand. (U.S.), Tech. Note 829, 67 pages (June 1974)

CODEN: NBTNAE

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1974

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
(Order by SD Catalog No. C13.46:829). Price \$1.10

PREFACE

This report is being written to satisfy the documentation requirements for transmitting to the Defense Communications Agency a plotting software package developed by NBS for their particular needs. It includes a User's Manual in Part I and a Programmer's Manual in Part II. It was felt that the applicability of this program to plotting any network makes it suitable for more general distribution.

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MULTICOMMODITY NETWORK PLOTTING

VIA PROGRAM NETPLT

Zella G. Ruthberg, Gloria R. Bolotsky, William Slater, Jr.**

ABSTRACT

In the design and operation of complex networks, it is often an advantage to obtain a visual representation that readily allows for a quick appraisal of the network's current configuration or of its changed appearance due to variations of its nodes and links. The program NETPLT enables a user to plot the two leading characteristics of any multicommodity network: 1) nodes and links and 2) the multiple source-sink structure (multicommodity property). The unique feature of NETPLT is its unambiguous planar representation of links. NETPLT uses an arc of a circle, instead of the usual straight line, to represent a connector between a node pair (link).

Key Words: Communication network; multicommodity network; network; network display; plotting algorithm; plotting program.

PART I USER'S MANUAL

1.0 GENERAL DESCRIPTION

1.1 Purpose of the User's Manual

The objective of this User's Manual is to provide the user with the information necessary to effectively use the NETPLT program.

1.2 Project Background

The Defense Communications Agency is concerned with various national and world-wide communications networks consisting of rate centers or switches (nodes) and their communication lines (links). In the design and operation of such complex networks it is often an advantage to obtain a visual representation that readily allows for a quick appraisal of the network's current configuration or of its changed appearance due to variations of its nodes and links. Such a need arose in a survivability study* being done for this agency at the National Bureau of Standards. The program NETPLT enables a user to plot the two leading

* The results of this study will be published by the National Bureau of Standards in a future Technical Note.

**Formerly summer student employee. Now with the Peace Corps.

characteristics of any multicommodity* network: 1) its nodes and links, and 2) the multiple source-sink structure imposed by the multiple command data** existing in the network. Within the resolution of the plot size used, the resulting network drawing is unambiguous. The manner of illustrating the multiple source-sink information on the network plot is also unambiguous but loses its definition if this data is too dense on any one plot. One must adjust the size of the plot to assure that clarity is not lost. (See Part II, Program Maintenance Manual for algorithms used.)

2.0 SYSTEM SUMMARY

2.1 System Factors

The program NETPLT contains 417 FORTRAN IV statements and has been run on the UNIVAC 1108 at NBS as well as compiled on an IBM 370/155 at the Defense Communication Agency's DCEC facility, Dereg Building, Reston, Virginia. It utilizes approximately 6800 words for the program code and the common blocks. It has been designed to accommodate a network of up to 900 nodes and an unrestricted number of links. If the number of nodes is to exceed 900, the five node-related arrays (see PART II, 2.2.1, variables 2, 3, 31, 47, 48) must have their dimensions correspondingly increased. The program expects the system to contain the CalComp software package and utilizes its subroutines PLOT, SYMBOL, NUMBER, and CIRCLE (See Part II, 2.1).

In any one run, the computer used generates a plot-tape that is compatible with its CalComp plotter. This tape drives the plotter in an off-line mode. The plotter at NBS is the CalComp 763, a machine having a continuous roll of 30" width paper. It can accommodate narrower paper widths, if desired. This plotter provides the operator with the option of manually selecting the pen color for any plot. The most commonly used colors are black, red, blue, and green, but others are available.

The program NETPLT can be used on other size CalComp plotter models such as the larger 718 with a 72" x 54" flatbed since the plotter dimensions are parameters of the program. If another model CalComp is used, its software calls should be checked to assure that the computer installation has not varied their parameter meanings.

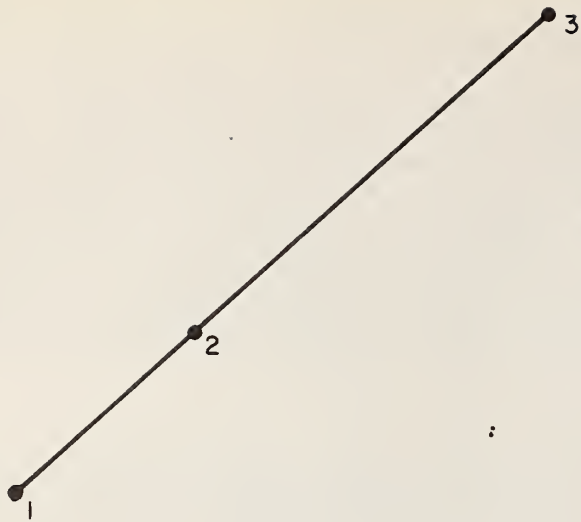
-
- * A multicommodity network has two sets of node sets, $S=s_1, \dots, s_g$ and $T=t_1, \dots, t_g$, such that the node set pair $[s_j, t_j]$ is associated with the transfer in the network of a distinct commodity j from sources s_j to sinks t_j . See [1], pg. 2, for more precise definitions in the subject area.
- ** In a military communications network each commander has a distinct commodity, his command's messages, and a distinct set of subordinates. The network connection nodes (homings) of each commander and his subordinates determine the sets of source and sink nodes for that command (commodity).

2.2 Rationale of NETPLT

2.2.1 Plotting the Network: The network is specified by its nodes (rate centers or switches) and its links (connected node pairs). The information needed by the program to uniquely locate a node on a plot is an identification code and a pair of x , y coordinates on some kind of rectangular grid. Link locations are then uniquely specified by a node code pair. However, the planar representation of such a link can be ambiguous when straight lines are used for such node pair connectors (see Figure 1). The program NETPLT eliminates this problem of ambiguity by using an arc of a circle as the planar representation of a connector between a node pair.

The uniqueness of this representation stems from the following considerations. The straight line drawn between a node pair can be considered as the chord of a circle subtending an angle δ at the circle's center (see Figure 2). For each node pair and angle δ there are two and only two circles possible. To reduce this number of possible arcs from two to one, the program was designed to draw all arcs with either a 'downward' or an 'upward' curvature. An arc has a 'downward' curvature when the radius to its center forms an angle with the horizontal ranging from greater than 0° through 180° . It has an 'upward' curvature when that angle ranges from greater than 180° through 360° (see Figure 3a). Figure 3b illustrates the range of arcs in a downward and an upward arc plot in relation to the angle α . Note that the angle α of the arc's chord with the horizontal covers the first and fourth quadrants of the plane for downward arcs and the second and third quadrants for upward arcs. The overlap at the boundary between these two regions in the plane was resolved by assigning $\alpha = +90^\circ$ to the downward arc plots and $\alpha = -90^\circ$ to the upward arc plots. A downward arc plot always draws the arc a in Figure 2 while an upward arc plot draws arc b . Figure 5 shows a simple network drawn first with downward arcs and then with upward arcs. Additional links between a given node pair are drawn by increasing the angle δ and thus changing the circle used. The limiting arc is the semicircle whose diameter is the chord drawn between the two nodes in question (see Figure 4). For reasons of resolution, a fixed interval between multiple links is specified in the program. This limits the number of multiple links that can be drawn. The network plot begins to lose some of its clarity if many widely separated node pairs are highly interconnected. (See PART II, 1.2 for the description of the geometry used.)

2.2.2 Plotting the Multiple Command Data: Since a network drawing can be expected to be a somewhat complex figure in itself, it was decided to indicate the multiple command information by means of points located alongside the border and connected via straight lines to the relevant network nodes. That is, each commander and each of his subordinates is represented by a point outside the network plot border. This point is then connected via straight lines to the network nodes that are its homings. Note that the program allows for up to five connection nodes



Is this a picture of:

- a) Link 1-3 and 1-2
- b) or Link 1-2 and 2-3
- c) or Link 2-3 and 1-3
- d) or Link 1-2 and 2-3 and 1-3

:

?

Figure 1. Ambiguity of Straight Lines for Links

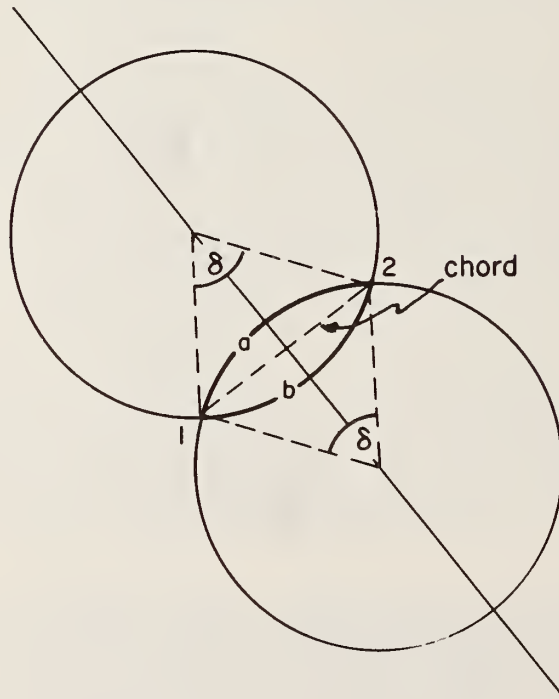
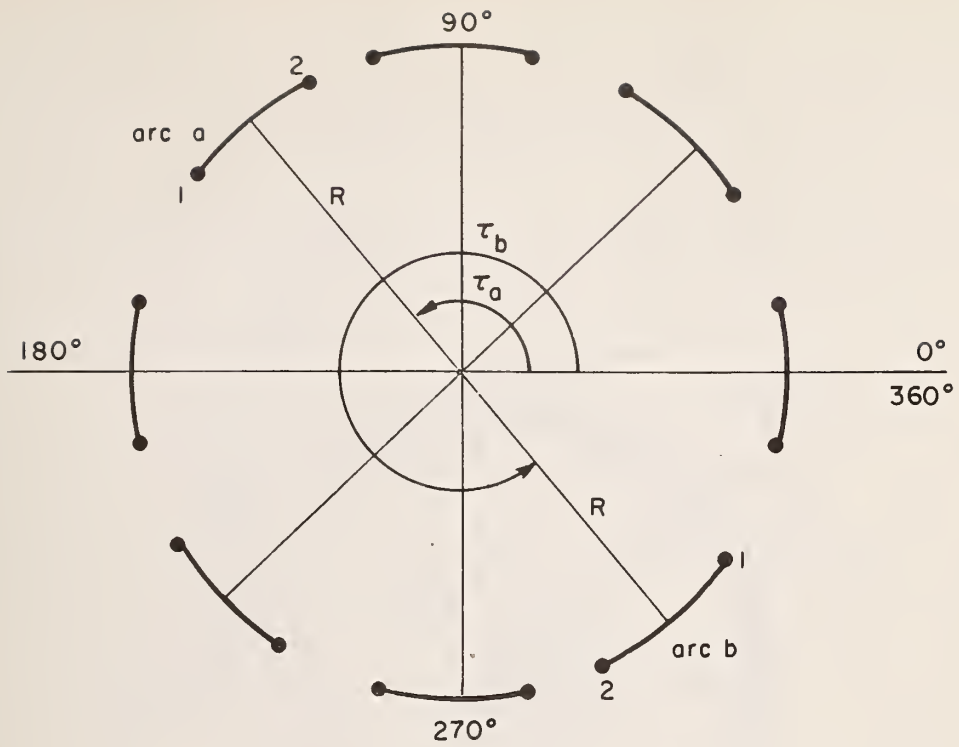


Figure 2. The Two Circles for Node Pair 1-2 that Subtend Angle δ .



Downward Arcs : $0^\circ < \tau_a \leq 180^\circ$

Upward Arcs : $180^\circ < \tau_b \leq 360^\circ$

Figure 3a. Possible Orientations For an Arc Having a Radius R .
Radius Points Down for "Downward Arcs".
Radius Point Up for "Upward" Arcs.

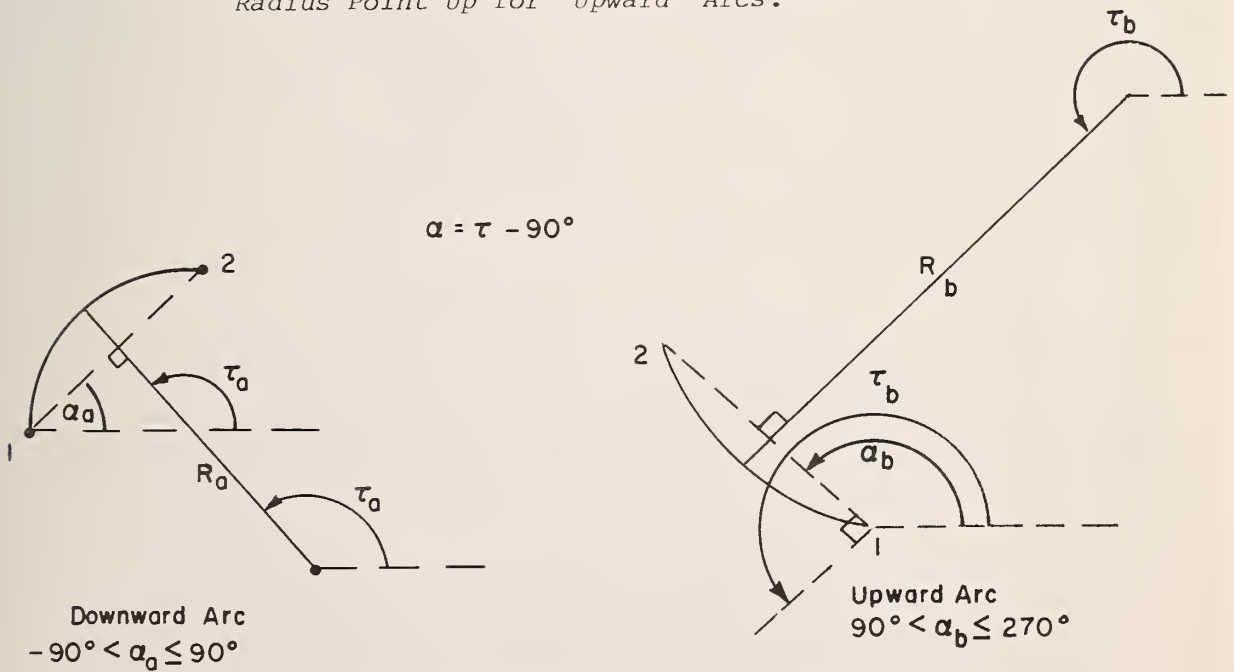


Figure 3b. Relation of Downward and Upward Arcs to Angle α .

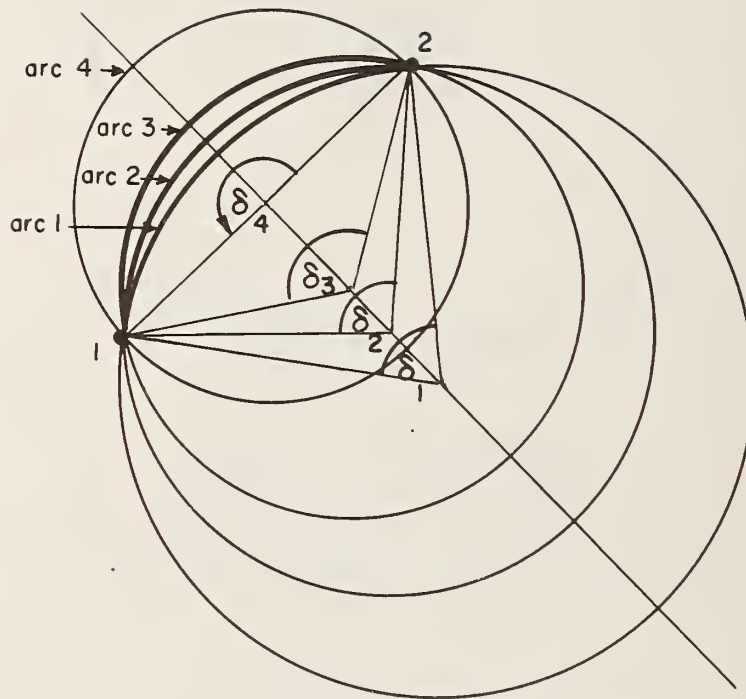


Figure 4. Primary and Secondary Arcs Between Nodes 1 and 2 --
Downward Arc Plot

TEST NETWORK--DOWNWARD ARCS

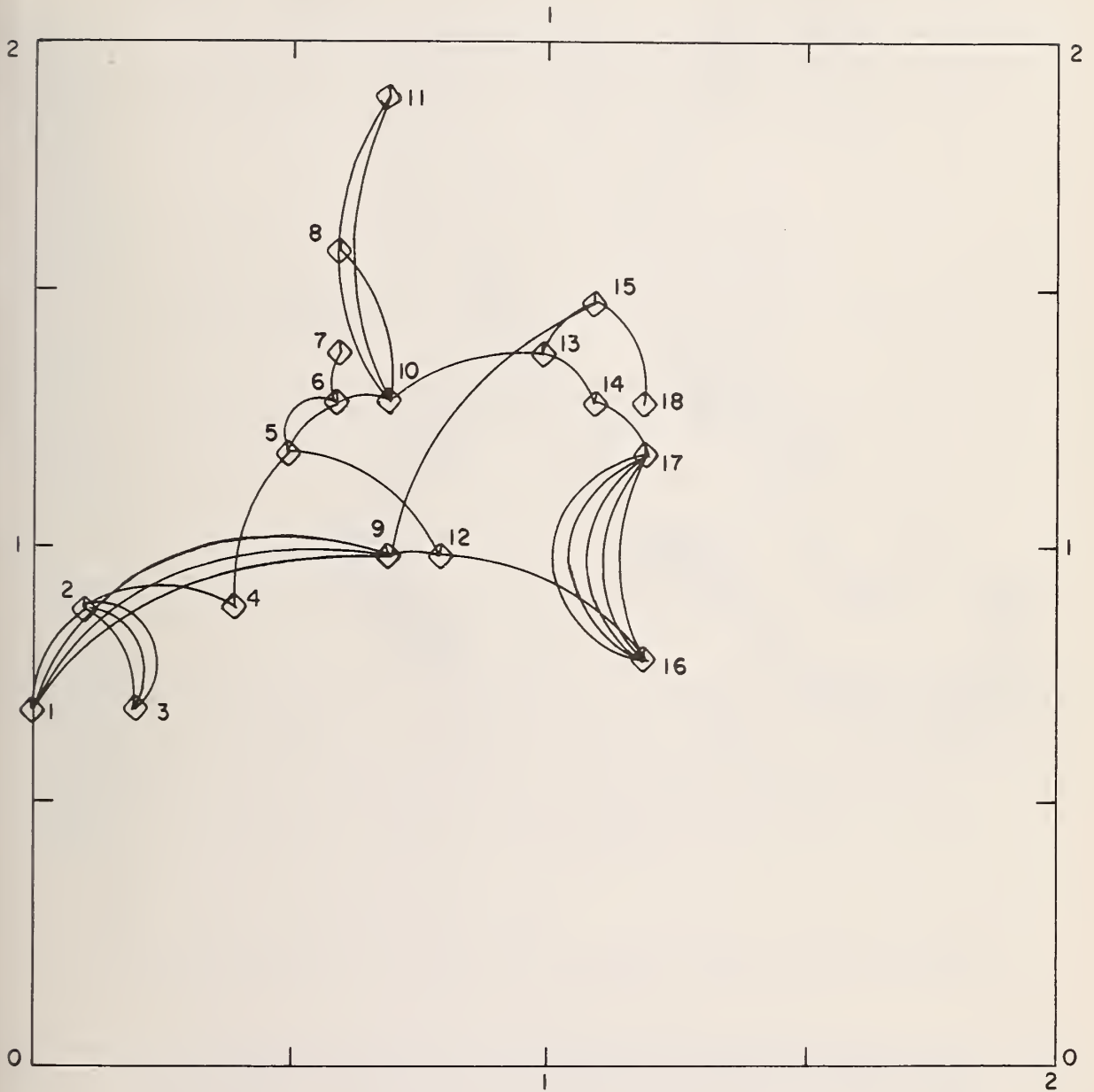


Figure 5a. Downward Arc Plot of Network in Figure 5b. (Type 2 Plot)

TEST NETWORK--UPWARD ARCS

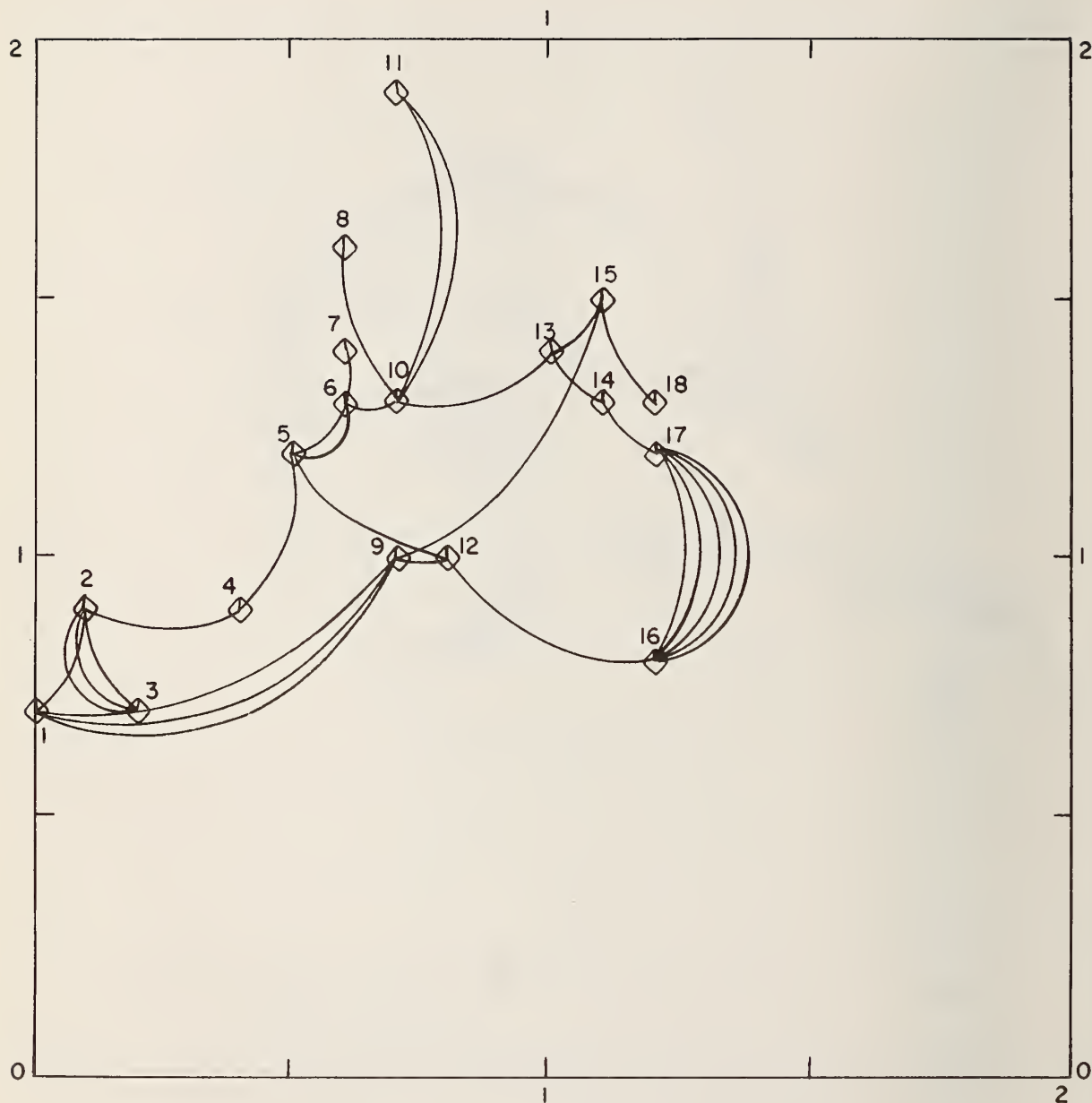


Figure 5b. Upward Arc Plot of Network
in Figure 5a. (Type 2 Plot)

per subscriber (commander or subordinate). A commander code number and a subordinate code number are used as a label near these exterior border points to inform the user as to which subscriber is involved (see Figure 6).

In order to minimize the lengths of these lines from the border into the network, a sort was evolved which locates these border points as closely as possible to their corresponding network nodes. This sort also distributes the subscriber points evenly around the border using this minimum distance concept. (See Appendix D for listing.)

2.3 Options of NETPLT

This program allows the user two basic plot options:

- 1) Draw the network and its subscriber (commander/subordinate) data on one sheet
- or 2) Draw the network on one sheet and its subscriber information on one or more additional transparent overlays.

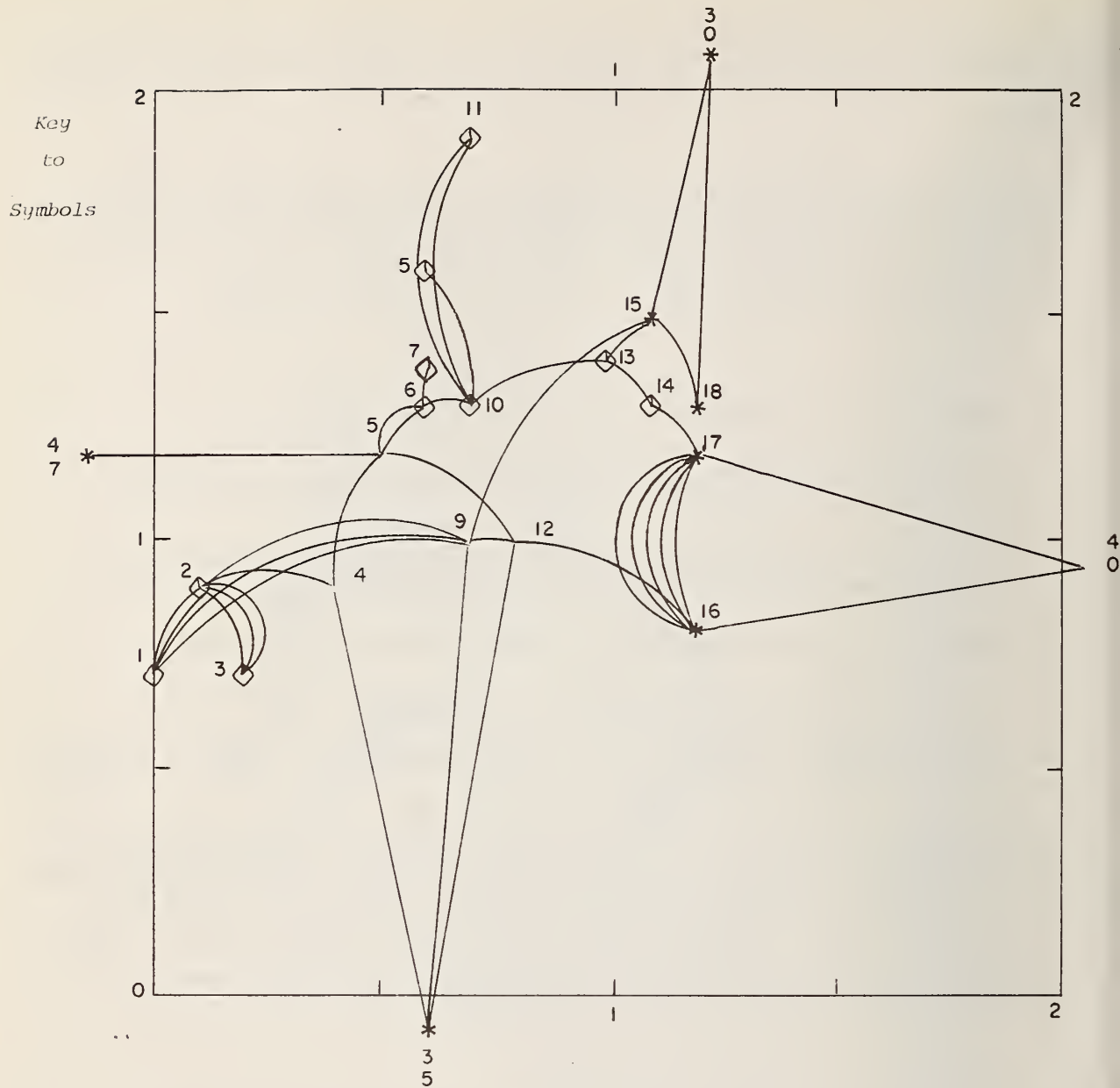
This second option is itself split into two options where either

- a) All subscriber information is plotted on a single overlay
- or b) Subscriber information for five commanders at a time is plotted on a single overlay.

By properly setting up the data deck, the 2a option can be used to plot only commander homings (connection nodes) and the 2b option to plot only subordinate homings (connection nodes). Note that for any one set of plots, all subscriber information is sorted at one time around the border so that each subscriber is assigned a unique location. (See Appendix D for the listing of this pre-sort.) This allows overlays to be viewed together as well as separately.

Some further general options are:

- 3) The plotter dimensions are parameters that can be changed by the user.
- 4) The dimensions of the total plot are parameters that can be varied by the user within the constraints of the plotter dimensions. Note that all plots in a single run have the same size, however.
- 5) The content of the heading on each plot must be composed by the user. (See PART I, 3.1.2, card 4.)



- 1) Network has 18 nodes, 30 links.
- 2) Command 3 enters at nodes 15 and 18.
His Subordinate 5 exits at nodes 4,
9, and 12.
- 3) Command 4 enters at nodes 16 and 17.
His subordinate 7 exits at node 5.

Figure 6. Plot Type 1 - Network Plus Subscribers

The program also contains the following four network options:

- 6) A downward or upward arc plot must be specified by the user.
- 7) One of the two symbols* provided by the program must be specified by the user to mark each network node's position.
- 8) A single arc or multiple arcs must be specified for each network link.
- 9) The node x, y coordinates may be in any units providing they are all in the same units. The program converts these to inches on the plotting paper.

2.4 Performance Experience

Following numerous test plots, the program has thus far been applied to two large networks: 1) a fictitious, sparsely** connected, 844 node, 1059 link network having 23 commanders with a total of 57 entries and 634 exits (comparable to national networks used by DCA) and 2) an 86 node, 761 link version of the world-wide Autovon network. The model 763 CalComp Plotter was used to generate plots on 60" x 30" sheets (paper or transparent matte triacetate).

2.4.1 Sparsely Connected Network: The fictitious sparsely connected national network was plotted on one sheet of matte triacetate, the commander structure on a second sheet of the same, and the subordinate structure on five subsequent sheets of that same material. The network was drawn in black ink, the commander plot in red ink, and the subordinate plot in blue ink since this plotter allows the operator a manual choice of pen colors before executing a plot. The nodes of the network were pre-sorted (see PART I, 2.6) monotonically increasing on x and alternately increasing and decreasing on y (for speedier plotting) and then given a sequential integer identification code (1 to 844). Ordinary nodes used one symbol while homing nodes used a second one. The links were pre-sorted so that the pen traced continuous paths through the network when drawing the links. Whenever a path terminated, the pen backtracked in a raised position to the last node with an untraced branch. This node was then chosen as the new starting point. (See Appendix D for listing of the sort.)

The input units for node data were on a 12 x 9 grid while the actual plot was on a 48" x 27" grid on the paper. Also the commanders

* The two symbols used by the program are * and \diamond .

** The number of links in a network of n nodes can vary from a minimum of (n-1) to a maximum of $\frac{n(n-1)}{2}$. A measure of the sparseness of a network is the ratio # of links/# of nodes. If this number is in the vicinity of 1 to 2 the network is considered sparsely connected.

and their subordinates were identified by an integer code. The entire set of plots required several hours for execution on the CalComp plotter. The computer run that generated the plot tape used about two minutes cpu time on the UNIVAC 1108 (EXEC II). (See Figure B1 for the network and some of its overlays.)

2.4.2 Densely Connected Network: The denser Autovon network required a few modifications to accommodate its idiosyncracies. Since there were three types of nodes, provision was made to increase the number of node symbols available to the program from two to three. Also, since the node identification code was alphabetic, this information was read and printed alphanumerically rather than in integer mode. Finally, since the links in this highly connected network were all of a multiple type, coding was added that printed this multiplicity number at the center of each arc. The data for this application was pre-processed so as to check for a connected network and for faulty or duplicate link entries. The network nodes and links were then pre-sorted in the same manner as the sparse network of 2.4.1 for speedier plotting. In this case, however, the input node data was converted from a latitude, longitude grid to a 60" x 27" plot on the paper. (See Figure B2 for this network.)

2.5 The Data Base

The bulk of the data for a run consists of the node set, the link set, and the subscriber set. The node set, which contains one card per node, has on that card the node identification code, the x, y coordinates of that node, and the type. (See PART I, 3.1.2, card 5.) The link set, which also has one card per link, contains the link's two incident node identification codes and its multiplicity.* (See PART I, 3.1.2, card 6) The subscriber set has two cards per subscriber (commander or subordinate) with the first card containing the number of homings and the second card containing the node identification codes of these homings. (See PART I, 3.1.2, cards 10 and 11.)

2.6 Preprocessing

The program plots the node set, the link set, and the subscriber set in the order in which they are read in. Hence, for speedier plotting, each of these sets of data is preprocessed via an appropriate sort. The nodes are sorted in narrow bands of monotonically increasing x values with the y values alternately increasing and decreasing in successive bands. The links are sorted into continuous chains through the network. Whenever a chain reaches an end point, the next chain starts with the last traced node with an untraced branch. The subscriber data for a run is sorted to minimize the distance from the border points to its homings. These are then spaced evenly around the

* The multiplicity of a link is the number of distinct connectors between its two incident nodes.

border with a minimum distance required between subscriber locations for best resolution. Since the natural distribution of the points around the border is in general uneven, manual adjustments are made before the subscribers are given their final coordinate values. (See Appendix D for the sort listings.)

2.7 Inputs and Outputs, General

2.7.1 Submitting a Run: The FORTRAN IV program must be submitted with the proper system control cards for the computer being used and with the appropriate data deck. Figure 7 shows the run deck and Figure 8 the data deck. The output of such a run is a printout of the network data (See Appendix A) and a plot-tape for the CalComp plotter. The program can readily be put on tape or disc if this offers advantages in its use.

2.7.2 Requesting a Plot: The format for requesting the off-line plot by the CalComp plotter varies from installation to installation. However, the most pertinent information that may be needed is the plot-tape identification code, the size and type paper needed, the color pen desired for each plot, the number of plots on the plot-tape, and an estimate of the time required for the plot.

3.0 INPUTS AND OUTPUTS, SPECIFIC

3.1 The Data Deck

The data deck consists of two basic sets of cards with the second set repeated for each plot in the run. Figure 8 shows a schematic drawing of a data deck and the following describes it in detail. The formats of the individual card types are shown in Figure 9 and their contents are described below.

3.1.1 Set One: This set contains information common to the four types of plots.

Card 1: Contains the number of nodes, the number of links, and the kind of curvature (up or down) desired. (See ICURV in PART II, 2.2.1.) If a run contains only subscriber plots, one can set the number of links and the curvature parameter to 0.

Card 2: Contains the number of plots, the length (in inches) of the x and y axes, the length (in input units)* of the x and y axes, the length (in inches) of the x and y plotter paper dimensions.

* The program allows for the use of any input units derived from a rectangular coordinate system.

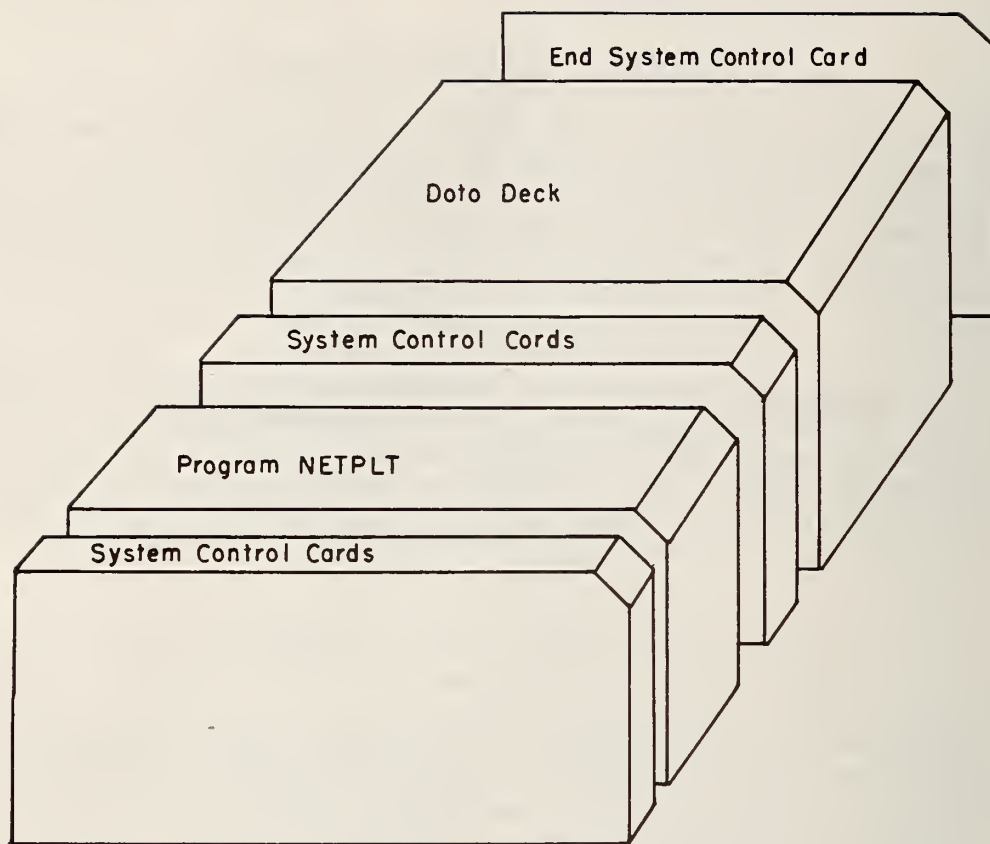
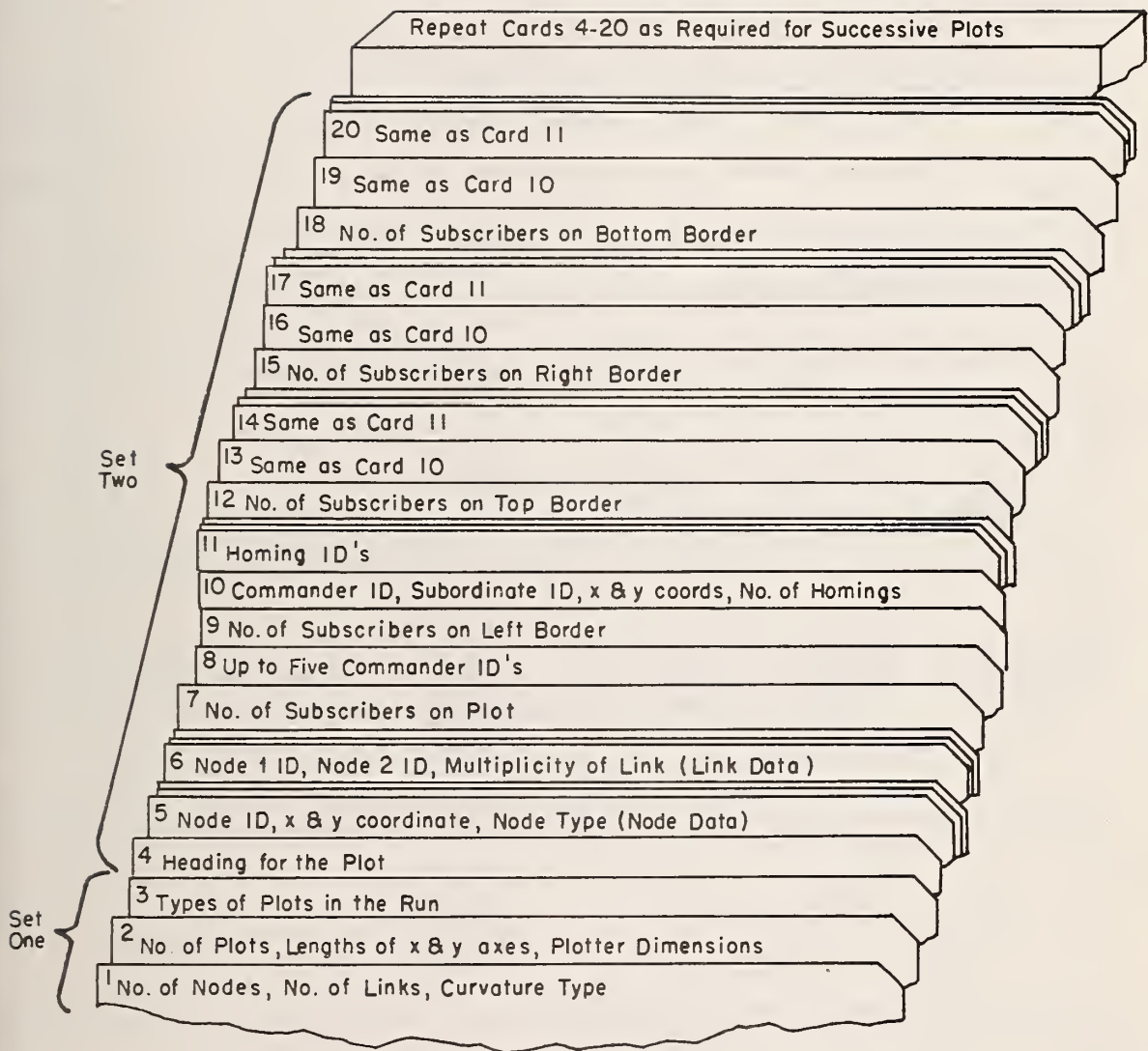


Figure 7. Deck for a Run of NETPLT.



Note: Cards 5, 6, 7, 9-20 are generated by the preprocessing routines.

Figure 8. The Data Deck.

Card 1	Col 1 n n n n n 5 NODES (I5) 6 n n n n n 10 LINKS (I5) 11 ICURV (I5) 15 n
Card 2	Col 1 n 5 NPLOT (I5) 11 n n n n n 15 XAXIS (F5.1) 21 n n n n n 25 YAXIS (F5.1) 31 n n n n n 35 SCALEX (F5.1) 41 n n n n n 45 SCALEY (F5.1) 51 n n n n n 55 PLOTX (F5.1) 61 n n n n n 65 PLOTY (F5.1)
Card 3	Col 1 n 5 LPTYPE(1) (I5) 6 n 10 LPTYPE(2) (I5) 11 n 15 LPTYPE(3) (I5) 16 n 20 etc. 21 n 25 [Can have one to nine fields filled]
Card 4	Col 1 HEAD (I2A6) [May use any characters. Can start with blanks] [Use 3 cards, excluding col. 73-80.] 72
Card 5	Col 1 n n n n n 5 NODEN(I) (I5) 36 n n n n n 40 UNITX(I) (F5.1) 41 n n n n n 45 UNITY(I) (F5.1) 60 n NTYPE (I 1) [1 card per node]
Card 6	Col 6 n n n n n 10 IP1 (I5) 11 n n n n n 15 IP2 (I5) 64 n 68 IFLAG (I 2) [1 card per link]
Card 7	Col 1 n n n n n 5 NSUBS (I5)

Figure 9a. The Data Deck Card Content

1	5	6	10	11	15	16	20	21	25	
n	n	n	n	n	n	n	n	n	n	
NCD (1)			NCD (2)		NCD (3)		NCD (4)		NCD (5)	
(I5)			(I5)		(I5)		(I5)		(I5)	

[Can have one to five fields filled]

1 5
| n n n n n |
K
(15)

```

1 5 6 10 36 45 46 55 56 60
|nnnnn|nnnnn|nnnnn.nnnnn|nnnnn.nnnnn|nnnnn|nnnnn|
|NCMD|NSUB|XUNIT|YUNIT|NHOME|
|(I5)|(I5)|(F10.5)|(F10.5)|(I5)|

```

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
NHM(1)					NHM(2)					NHM(3)					NHM(4)					NHM(5)				
(I5)					(I5)					(I5)					(I5)					(I5)				

[Can have one to five fields filled]

Cards 12, 13, 14; 15, 16, 17; and 18, 19, 20 repeat cards 9, 10, 11.

Note: Each field on the card contains its column range, its integer content (denoted by n's), its variable name, and its format. All numbers are right justified. The values possible for any n are blank, 0, 1, 2, ... 9. Decimal numbers have the decimal point shown.

Figure 9b. The Data Deck Card Contents (cont'd.)

Card 3: Contains the types of plots in the run. (See LPTYPE in Part II, 2.2.1.)

3.1.2 Set Two: This set consists of the specific information needed for each plot. Not all card types appear for each type plot (LPTYPE). Therefore, each card now described has a note indicating the plot type.

Card 4: (For all plot types.) Contains the heading for the plot. It can be in alphanumeric form and consists of a maximum of 216 characters on 3 cards, 72 characters per card. These 216 characters are centered at the top of the plot.

Card 5: (For the first plot in the run only.) Contains the node data, one card per node. Each card carries the node identification code, the x coordinate (in input units), the y coordinate (in input units), and the node type. (See NTYPE in PART II, 2.2.1.)

Card 6: (For plot types 1 or 2 only.) Contains the link data, one card per link. Each card consists of the identification code of node 1, the identification code of node 2, and the multiplicity of the link.

Card 7: (For plot types 1, 3, or 4 only.) Contains the number of subscribers for the current plot.

Card 8: (For plot type 4 only.) Contains the identification code numbers of up to five commanders for a plot.

Card 9: (For plot types 1, 3, or 4 only.) Contains the number of subscriber points along the left border, starting at the lower left corner and ending at the upper left corner.

Cards 10 and 11: (For plot types 1, 3, or 4.) Contain the subscriber data, one pair of cards 10 and 11 per subscriber on left border.

Card 10: Contains the commander identification code, the subordinate identification code, the x and y coordinates (in inches) of the subscriber points, and the number of homings.

Card 11: Contains the identification codes of the homings for the subscriber in Card 10.

Cards 12, 13, and 14: Repeat cards 9, 10, and 11 for subscribers along the top border, from left to right.

Cards 15, 16, and 17: Repeat cards 9, 10, and 11 for subscribers along the right border, from top to bottom.

Cards 18, 19, and 20: Repeat cards 9, 10, and 11 for subscribers along the bottom border, from right to left.

The data for the first plot in a run contains the appropriate card types selected from 1 to 20 and always includes node data (card 5). The data for successive plots in a run contain the appropriate card types from 4 to 20, omitting the node and link data (cards 5 and 6).

3.2 NETPLT Outputs

The outputs of the NETPLT program consist of the computer printout, the plot-tape for the CalComp plotter, and the plots drawn by the CalComp plotter.

3.2.1 The Computer Printout: The computer printout always contains a network heading and a node table. For plot types 1 or 2, the link table appears next. Finally, for plot types 1, 3 or 4, the subscriber table appears. Note that each subscriber plot in a run has its own heading and this heading precedes the subscriber table in the printout. See Appendix A for sample.

The node table contains a line of printout for each node. On this line, from left to right, are the node identification code number, its x and y coordinates in input units, its x and y coordinates in inches, and its type (NTYPE). Type 0 is an ordinary node while type 1 is a homing node. (See Appendix A.1 for sample printout.)

The link table contains a line of printout for each link. On this line, from left to right, are the link identification code number, its node 1 code number, its node 2 code number, the multiplicity of that link, and the number of links plotted. Whenever a secondary link is plotted between two nodes, an additional line of printout appears, preceding the primary link line in the table. It lists the link counter, starting at one, and its angles PHI , $T1$, and $T2$. (See PART II, 2.2.3 for definitions.) This secondary link printout is included for checking purposes since these angles can be hand calculated. (See Appendix A.2 for sample printout.)

Each subscriber table contains a heading (unless the plot is of type 1) and a line of information per subscriber. On this line is the commander code number, the subordinate code number, the x and y coordinates (in input units) of the border node representing it, these same coordinates in inches, the number of homings, and the code numbers of these homings (one to five of them allowed). (See Appendix A.3 for sample printout.)

3.3 CalComp Output

The plot tape contains the instructions for the CalComp plotter and must be submitted for plotting according to the installation's

procedures. (See PART I, 2.7.2.) Each plot proceeds with the placement of the heading at the top and the drawing of a border with the specified dimensions. Tic marks are drawn at half input unit intervals with their integer numerical values drawn at the whole input unit intervals. The specific plot, which can be one of four types, is then drawn. Type 1 plots the network and all subscribers on one sheet, type 2 plots only the network on the sheet, type 3 plots only subscribers (or commanders) on one sheet, and type 4 plots subscribers or subordinates, up to five commands at a time. Finally, each plot has an appropriate key to the node symbols on that plot in the upper left corner of the paper. For examples of the plots, see Figures 5 and 6 and Appendix B. For further details about the key, see Part II, 2.3.1.

PART II PROGRAM MAINTENANCE MANUAL

1.0 GENERAL DESCRIPTION

1.1 Purpose

The objective of this manual is to provide maintenance programmer personnel with the information necessary to effectively maintain or modify the program NETPLT.

1.2 The Basic Algorithms

Peripheral calculations such as the conversion factors in the x and y directions from node coordinates to inches, the drawing of the border, and the annotation for the border and key to symbols, are straightforward and require little explanation. However, the heart of this program is based on some circle geometry which is more involved and will now be discussed. As mentioned in PART I, 2.2.1, every link can be represented by the arc of one of two circles. Figure 10 shows the geometry applicable to both the downward and upward arc cases. Note that x_1 and x_2 are chosen so that $x_1 \geq x_2$ for all downward arcs and $x_1 \leq x_2$ for all upward arcs.

The range for angle δ found most suitable in tests was 30° to 60° , but the value finally used in the two large networks was 60° . The information needed by the CIRCLE routine in CalComp software is β_1 (the angle with the horizontal of node 1's circle radius), β_2 (the angle with the horizontal of node 2's circle radius), and R (the radius of the circle whose arc is being drawn). These quantities are calculated as follows:

$$\gamma = \frac{\delta}{2} \quad (1.2.1)$$

$$\omega = 90^\circ - \gamma \quad (1.2.2)$$

$$L = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \quad (1.2.3)$$

$$\alpha = \arcsin \frac{y_1 - y_2}{L} \quad (\text{downward arcs}) \quad (1.2.4.1)$$

$$\alpha = \arcsin \frac{y_2 - y_1}{L} + 180^\circ \quad (\text{upward arcs}) \quad (1.2.4.2)$$

$$R = \frac{L}{2 \cos \omega} \quad (1.2.5)$$

$$\beta_1 = \alpha + \omega \quad (1.2.6)$$

$$\beta_2 = \beta_1 + \delta \quad (1.2.7)$$

Note that the case $x_1 = x_2$ is made unique by arbitrarily assigning $\alpha = +90^\circ$ to downward arc plots and $\alpha = -90^\circ$ to the upward arc plots.

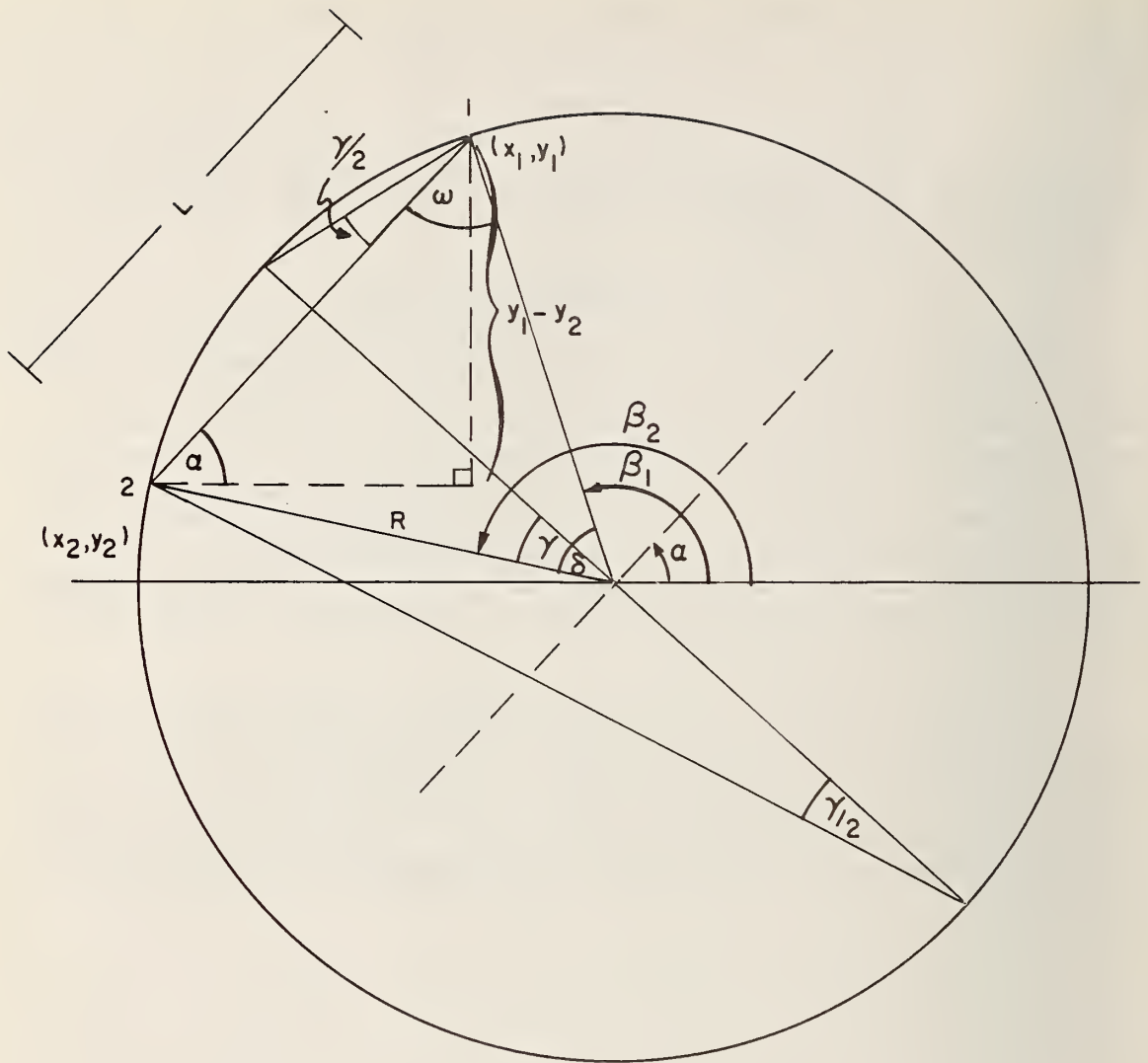
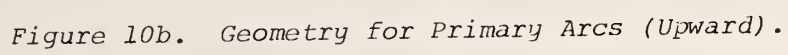


Figure 10a. Geometry for Primary Arcs (Downward)



Secondary arcs are drawn using the geometry of Figure 11. The value chosen for D , the distance between arcs, was set at .1 inches for reasonable resolution. The quantities needed by the CalComp CIRCLE routine for the secondary arc are θ_1 , θ_2 , and R . The equations used are:

$$m = \frac{L}{2} * \tan \frac{\gamma}{2} \quad (1.2.8)$$

$$n = D + m \quad (1.2.9)$$

$$*R_2 = \frac{n^2 + \left(\frac{L}{2}\right)^2}{2 * n} \quad (1.2.10)$$

$$\phi = \arcsin \frac{L}{2 * R_2} \quad (1.2.11)$$

$$\theta_1 = \beta_1 + \gamma - \phi \quad (1.2.12)$$

$$\theta_2 = \theta_1 + 2 \phi \quad (1.2.13)$$

It should be noted that all trigonometric function subroutines using these angles require them in radians while the CalComp Routine calls use degrees. The program does the proper conversion where necessary.

A flag (IDIR) is introduced to indicate the direction, clockwise or counter clockwise, for drawing an arc. Thus, the plotter pen will draw a series of arcs -- multiple arcs or arcs in a path -- with a minimum amount of movement. (See Figure 12.)

2.0 SYSTEM DESCRIPTION

2.1 CalComp Subroutines Used

The program NETPLT uses four subroutines, PLOT, SYMBOL, NUMBER, and CIRCLE, from the CalComp software package. A brief description of these routines will be given here, but more detailed information can be found in references [2] and [3].

* Using Figure 11, we can see that $R_2^2 = \left(\frac{L}{2}\right)^2 + (R_2 - n)^2$. Solving for R_2 yields equations 1.2.10.

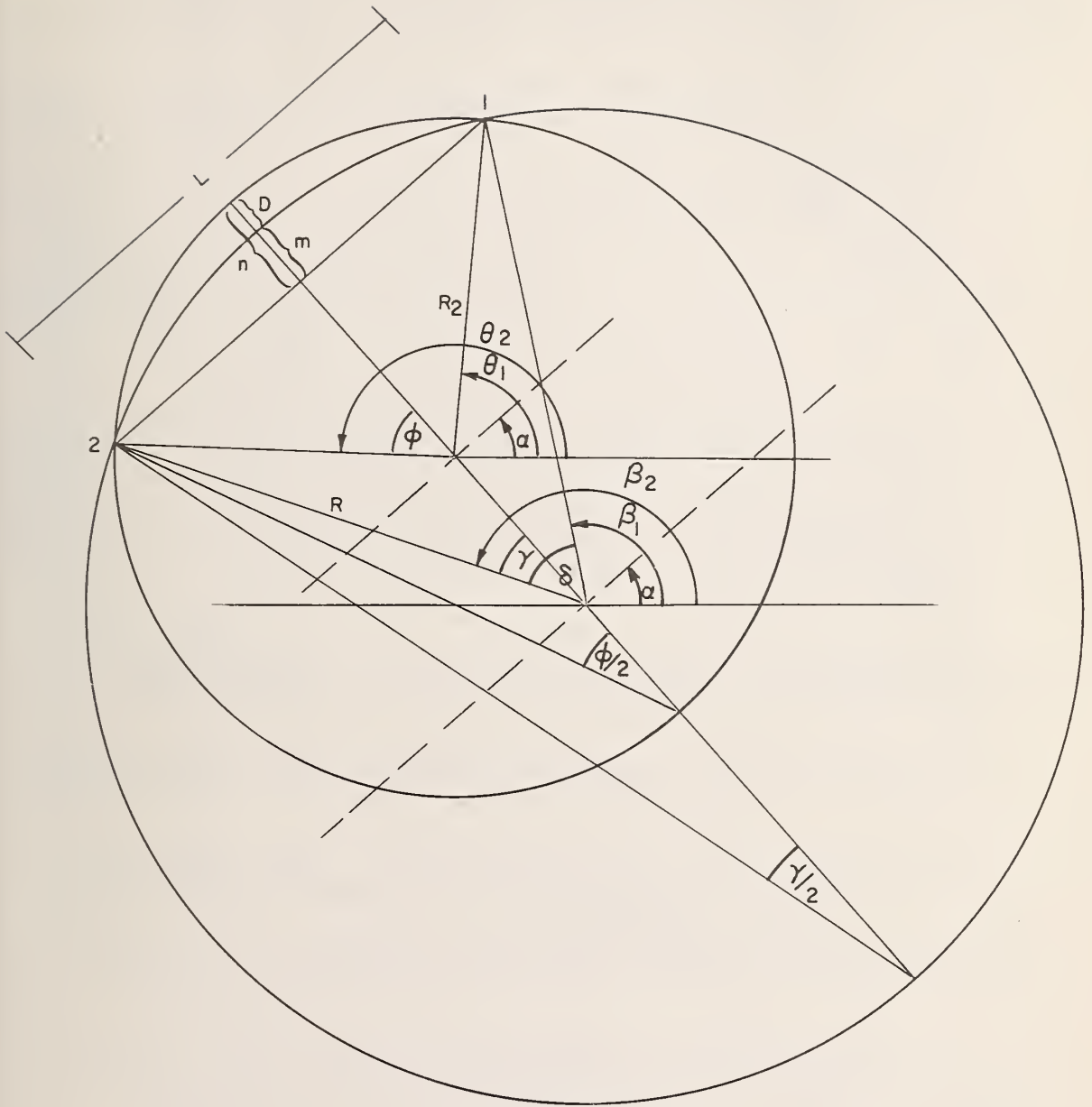


Figure 11. Geometry for Secondary Arcs (Downward)
 (Note: For upward arcs reverse points
 1 and 2 as in Figure 10b.)

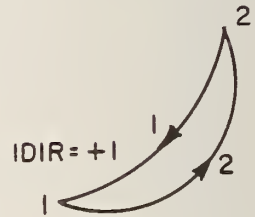
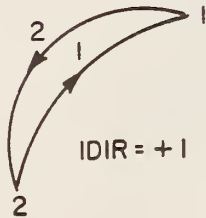
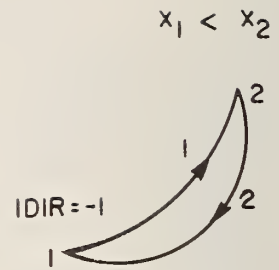
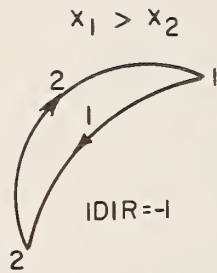


Figure 12. The Four Possible Ways to Start Drawing Multiple Arcs.
Draw Arc 1 and Then Arc 2.

2.1.1 PLOT: This routine converts all plotting data to hardware codes for a pen plotter and handles all output to the tape or controller. It buffers and controls the output without user intervention.

2.1.2 SYMBOL: This routine writes alphanumeric text and special symbols anywhere and at any angle desired on the plot.

2.1.3 NUMBER: This routine writes computer values on the plot in a format (integer or decimal) chosen by the user.

2.1.4 CIRCLE: This routine draws a circle, arc, or spiral starting at a given point on the plot.*

2.2 Variables and Arrays in NETPLT

The following is an alphabetical listing by program segment of all the significant variables that appear in each segment. Note that the standard word type convention has been followed where all words are real except those beginning with letters I to N. Those variables and arrays which store data from the data deck are followed by the word Data. Also, array names are always followed by their dimensions.

2.2.1 MAIN:

- (1) BUFF (1100) - an array used as a buffer by the CalComp routine PLOT to block the information going out on the plot tape.
- (2) COORDX (900) - an array used to store the x coordinate, in inches, of the nodes in the network.
- (3) COORDY (900) - an array used to store the y coordinate, in inches, of the nodes in the network.
- (4) CX - the x conversion factor for transforming a node's input x coordinate into inches on the plot paper. In common block BRDR.
- (5) CY - the y conversion factor for transforming a node's input y coordinate into inches on the plot paper. In common block BRDR.
- (6) DEG - the angle δ subtended by the arc drawn between two network nodes. Presently set to 60° .
- (7) DI - a parameter used by the CIRCLE subroutine to indicate that a solid arc ($DI=0.0$) or a dashed arc ($DI=0.5$) is to be drawn. In common block ARC.

* A modified version of CIRCLE which takes two thirds of the time has been written. See reference [2], pg. 7.

- (8) FP - a floating point version of the commander identification number. This form is needed by subroutine NUMBER.
- (9) FPN - a floating point representation of an integer needed by subroutine NUMBER. (Same purpose as FP.)
- (10) FRN - same as FPN.
- (11) HEAD (36) - the array that stores the heading for a plot. In common block BRDR. Data.
- (12) HT - the height of the input unit integers around the border, the commander and subordinate code numbers around the border, and the node code numbers in the network plot. Presently set at .1. In common block BRDR.
- (13) ICURV - the flag for indicating a downward arc (ICURV=1) or an upward arc (ICURV=2) network plot. In common block ARC. Data.
- (14) IFLAG - stores the number of multiple links between a network node pair. In common block ARC. Data.
- (15) IFLG - a flag used in the program to draw multiple homing links (links from a subscriber to his network nodes) with a minimum amount of lifting of the pen.
- (16) IP1 - the node code number for a link's first node. Data.
- (17) IP2 - the node code number for a link's second node or the code number of a homing node. Data.
- (18) IREAD - the logical unit number for the computer input read device. Presently set to 5.
- (19) ITYPE - the type of the plot currently being done. Same meaning as contents of LPTYPE. Can have values 1, 2, 3, or 4.
- (20) IWRITE - the logical unit number for the computer system's output print device. Presently set to 6. In common block ARC.
- (21) K - the number of subscriber points along one edge of the border. Obtained from pre-sorting the data. Data.
- (22) L - the symbol code for a network node or a subscriber point being drawn on the plot. The plotter has twelve similarly drawn symbols available if others are preferred.
- (23) LINKS - the number of links in the network plot. Data.

- (24) LL(5) - an array containing the symbol code for a subscriber node along the border of an ITYPE=4 plot. Presently set to 0, 1, 2, 6, 10. This symbol code may change with the installation.
- (25) LPTYPE(9) - an array containing the type of each plot in the run. A run is limited to nine plots. Data.
- LPTYPE=1 <=> plot network plus subscribers on the border.
- LPTYPE=2 <=> plot network only.
- LPTYPE=3 <=> plot an overlay with all subscribers or commanders only on border. All commands use the same symbol.
- LPTYPE=4 <=> plot an overlay with at most five commanders and/or subordinates on the border. Each command uses a distinct symbol.
- (26) N - the number of the edge along which subscribers are being plotted.
- (27) NCD(5) - an array storing the five commander code numbers for plot of ITYPE=4. Data.
- (28) NCMD - the code number of the command for the current subscriber. Data.
- (29) NHM(5) - an array storing the network node code numbers of the homings for a subscriber. Data.
- (30) NHOME - the number of homings for a subscriber. Data.
- (31) NODEN(900) - the sequential code numbers of the network nodes. Data.
- (32) NODES - the number of nodes in the network plot. Data.
- (33) NOPLT - the number of multiple links plotted between a network node pair. In common block ARC.
- (34) NPL - the number of plots to be drawn in the run. Same as NPLOT.
- (35) NPLOT - the number of plots to be drawn in the run. Data.
- (36) NSUB - the code number of the current subordinate being plotted. If NSUB=0, the border point refers to a commander entry. Data.
- (37) NSUBS - the total number of subscribers in the current run. Data.

- (38) NSUM - a word accumulating the number of subscribers plotted. After all plots in the run are drawn, NSUM should equal NSUBS.
- (39) NTYPE - the type of a network node. Data.
- NTYPE=0<=> an ordinary node.
- NTYPE=1<=> a subscriber homing node.
- (40) PLOTX - the x dimension of the plotter or the size paper used (in inches). Data.
- (41) PLOTY - the y dimension of the plotter or the size paper used (in inches). Data.
- (42) POINT - the x coordinate of the starting point of the plot's heading.
- (43) PY - the y coordinate of the starting point of the plot's heading.
- (44) SCALEX - the length of the plot's x axis in input units. Data.
- (45) SCALEY - the length of the plot's y axis in input units. Data.
- (46) TEMP - a temporary storage location.
- (47) TIC - the height of the tic marks along the border. Presently set to .5 inches. In common block BRDR.
- (48) UNITX(900) - the x coordinate of the network nodes in input units. Data.
- (49) UNITY(900) - the y coordinate of the network nodes in input units. Data.
- (50) XAXIS - the length of the plot's desired x-axis, in inches. In common block BRDR.
- (51) XCOORD - a word used to store a node's x coordinate for use by subroutine SYMBOL.
- (52) XII - the x coordinate, in inches, of the lower left corner of the border for a plot.
- (53) XIPl - the x coordinate, in inches, of node 1 for a link. Used for network links or subscriber links. In common block ARC.

- (54) XIP2 - the x coordinate, in inches, of node 2 for a link. Used for network links or subscriber links. In common block ARC.
- (55) XL - the length assigned to a heading (3 cards of 216 characters).
- (56) XUNIT - the x coordinate, in input units, of a subscriber point along the border. Data.
- (57) XX - the x coordinate, in inches, of the commander and subordinate code number. Used for plotting purposes.
- (58) YAXIS - length, in inches, of the plot's desired y-axis. In common block BRDR.
- (59) YCOORD - a word used to store a node's y coordinate for use by subroutine SYMBOL.
- (60) YII - the y coordinate, in inches, of the lower left corner of the border for a plot.
- (61) YIP1 - the y coordinate, in inches, of node 1 for a link. Used for network links or subscriber links. In common block ARC.
- (62) YIP2 - the y coordinate, in inches, of node 2 for a link. Used for network links or subscriber links. In common block ARC.
- (63) YJ - the y coordinate, in inches, for the code number of a subordinate. Used by subroutine NUMBER.
- (64) YUNIT - the y coordinate, in input units, of a subscriber point along the border. Data.
- (65) YY - either the y coordinate, in inches, of the code number of a commander, or the y coordinate of the words in the plot's key to the symbols. Used by subroutine SYMBOL.

2.2.2 BORDER

- (1) CX - same as in 2.2.1.
- (2) CY - same as in 2.2.1.
- (3) DIF - the difference, in inches, between the specified XAXIS or YAXIS and the nearest integer number of input data units that fit into XAXIS or YAXIS.

- (4) FPN - a floating point representation of the tic mark integer along the border. Needed by subroutine NUMBER.
- (5) HEAD(36) - same as in 2.2.1.
- (6) HT - same as in 2.2.1.
- (7) K - the nearest integer number of input data units in XAXIS or YAXIS.
- (8) S - the number of inches along the x or y axis that contain the integer number of input data units along that axis.
- (9) TIC - same as 2.2.1.
- (10) X - used most often as the x coordinate, in inches, for the drawing of the border.
- (11) XAXIS - same as 2.2.1.
- (12) XX - used most often as the x coordinate, in inches, of the tic mark integer to be drawn.
- (13) Y - used most often as the Y coordinate, in inches, for the drawing of the border.
- (14) YAXIS - same as 2.2.1.
- (15) YY - used most often as the Y coordinate, in inches, of the tic mark integer to be drawn.

2.2.3 PLTARC: (See Figures 10 and 11.)

- (1) A - the angle α made by a link's chord with the horizontal. In degrees.
- (2) AM - the maximum distance m , along a radius, between a primary link's chord and its arc. (See Figure 11.)
- (3) AN - the maximum distance n , along a radius, between a secondary link's chord and its arc. (See Figure 11.)
- (4) B1 - the angle β_1 , formed by the primary circle's radius to node 1 and the horizontal.
- (5) B2 - the angle β_2 , formed by the primary circle's radius to node 2 and the horizontal.

- (6) D - the distance between a primary arc and its secondary arc.
- (7) DEG - the angle δ subtended by the arc drawn between nodes 1 and 2.
- (8) DI - same as in 2.2.1.
- (9) DIST - the length L of the chord between nodes 1 and 2.
- (10) DIST2 - one-half of the length L .
- (11) GAMA - half of the angle δ , in degrees. Denoted by γ in Figure 10.
- (12) GAMAR - the angle γ in radians.
- (13) ICURV - same as 2.2.1.
- (14) IDIR - a flag for drawing secondary arcs more efficiently.
IDIR=1 \Rightarrow draw arc clockwise from node 2 to node 1.
IDIR=-1 \Rightarrow draw arc counter clockwise from node 1 to node 2.
- (15) IFLAG - same as in 2.2.1.
- (16) IND - a counter for the number of secondary links drawn.
- (17) IWRITE - same as in 2.2.1.
- (18) NOPLT - same as in 2.2.1.
- (19) OMEG - the angle ω which, when added to angle α , yields angle β_1 . In degrees.
- (20) OMEGR - the angle ω in radians.
- (21) PHI - the angle ϕ , which is half the subtended angle for secondary arc. Analogous to γ .
- (22) R - the radius of the circle upon which a primary arc is drawn.
- (23) R2 - the radius of the circle upon which a secondary arc is being drawn.
- (24) TEMP - a temporary storage location.
- (25) T1 - the angle Θ_1 , formed by the secondary circle's radius to node 1 and the horizontal. Analogous to β_1 .

- (26) T_2 - the angle θ_2 , formed by the secondary circle's radius to node 2 and the horizontal. Analogous to β_2 .
- (27) XIP1 - same as in 2.2.1.
- (28) XIP2 - same as in 2.2.1.

2.3 Components of NETPLT

2.3.1 MAIN: The two initial read statements establish the size of the network (number of nodes and links), the type of arcs chosen (upward or downward), the number of plots for the run, the length of the x and y axis in inches and input data units, and the x and y dimensions of the plotter paper. The program then sets up a scale factor for each dimension and initializes the location of the plotter pen in the lower left corner of the paper. Next, the types of the plots are read into an array LPTYPE. The DO 100 loop then draws each of the plots, branching within itself for each type.

For all four type plots, the heading is read and written on the run's printout. Then subroutine BORDER is called in to draw the border. (See 2.3.2.) In the DO 10 loop, the node data, consisting of the node code number, its x and y coordinates, and its node type is read. The program then plots the node symbols with their identification codes above them, for types 1 and 2, and, for all type plots, writes the node table in the printout. Plot types 1 and 2 then go into the link plotting phase. The DO 20 loop reads in the link node pairs and their multiplicity number, calls on PLTARC to plot the arcs, and writes the link table in the printout.

At this point, plot types 1, 3, and 4 go on to draw subscribers. For the subscriber plotting, the individual plot's number of subscribers is read, and then, for type 4, commander code numbers are read in. Then, for each of the four edges of the border, the number of subscribers along that border edge is read from one card; the commander code number, subordinate code number, subscriber node x and y coordinates, and the number of homings are read from a second card; the code number for each commander/subordinate node is drawn (using the convention that a subordinate code number of zero means the node is a commander); the subscriber homing nodes are read from a third card; and the straight line connectors between subscriber points on the border and homings are drawn. The second and third cards are repeated for each subscriber along the border edge. During this part of the program the subscriber data is also written into a table for the printout.

For all type plots the heading is drawn across the top and a key to the symbols is drawn in the upper left corner of the paper. For type 1 and 2 plots the symbols for an ordinary network node and a homing node are shown in the key; for types 1 and 3 the explanation of the border

node symbol is given in the key lower down on the paper; and finally, for type 4 the explanation of the border point symbols and their correlation to commanders is given still further down on the paper. The entries in the key are spread down the page so that they can be read when several transparent plots are viewed together. (See Appendix B figures for samples of this key.)

2.3.2 BORDER: This subroutine draws the border for a plot, starting in the lower left corner and proceeding continuously along the lower, the right, the top, and the left edges. Tic marks are drawn at half integers and numbers added at the whole integers. The input Data units are used for the scale.

2.3.3 PLTARC: This routine does all the network arc plotting. The crucial information that it needs is the flag for upward or downward arcs (ICURV), and the coordinates of nodes 1 and 2. For downward arcs, XIP1 must be greater than XIP2 while for upward arcs XIP1 must be less than XIP2. The program examines the coordinates and may interchange them to assure that this is the case. The tie for the equality case is broken by arbitrarily assigning $\alpha = +90^\circ$ to downward arc plots and $\alpha = -90^\circ$ to upward arc plots. The flag IDIR is always initially set so that counterclockwise arcs are drawn from node 1 to node 2 and clockwise arcs from node 2 to node 1. The length of the link's chord (DIST), and the quantities GAMA, OMEG, OMEGR, DIST2, and R are then calculated. The proper values of A, B1, and B2 for upward or downward arcs is then obtained and the clockwise or counterclockwise arc drawn.

If secondary arcs are to be drawn, the counter NOPLT is initiated to 1, the quantity AM is calculated, and the proper R2, PHI, T1 and T2 obtained. These values appear in the link table in the printout and then the clockwise or counterclockwise secondary arc is drawn. IDIR is alternated between 1 and -1 so that secondary arcs are drawn without lifting the pen. The drawing of secondary arcs ceases when all multiple arcs are drawn or the last arc is as close as possible to the semicircle.

3.0 INPUT/OUTPUT DESCRIPTION

The inputs, outputs, and data deck have been described in full in PART I and will not be described here. Figure 9 shows the data deck card formats while Figures 7 and 8 show the run deck and data deck, respectively.

REFERENCES

- [1] Ruthberg, Z. G., Bellmore, M., *User's Manual for Program DFENSE*, NBS Report 10821, January 1972.
- [2] Ruthberg, Z. G., Bolotsky, G. R., *Programmer's Manual for the ONC Map Plotting Program SILOT*, NBS Report 10619, October 1971.
- [3] CalComp Software Reference Manual, California Computer Products, Inc., Anaheim, California 92803, February 1968.

A.1 Node Table

INITIAL NETWORK

NODEN	COORDINATES OF NODE				TYPE
	INITIAL		INCHES		
	UNITX(1)	UNITY(1)	COORDX(1)	COORDY(1)	
1	.0	.7	.0	2.1	1
2	.1	.9	.4	2.7	0
3	.2	.7	.9	2.1	0
4	.4	.9	1.6	2.7	0
5	.5	1.2	2.0	3.6	0
9	.6	1.6	2.4	4.8	0
8	.6	1.4	2.4	4.2	0
7	.6	1.3	2.4	3.9	0
6	.6	.8	2.4	2.4	0
10	.7	.8	2.8	2.4	0
11	.7	1.0	2.8	3.0	0
12	.7	1.3	2.8	3.9	0
13	.7	1.9	2.8	5.7	1
15	.8	1.0	3.2	3.0	0
14	.8	.8	3.2	2.4	0
16	.9	1.0	3.6	3.0	0
18	1.0	1.4	4.0	4.2	0
17	1.0	1.2	4.0	3.6	0
19	1.1	1.3	4.4	3.9	0
20	1.1	1.5	4.4	4.5	0
21	1.1	1.6	4.4	4.8	1
25	1.2	1.3	4.8	3.9	0
24	1.2	1.2	4.8	3.6	0
23	1.2	.8	4.8	2.4	1
22	1.2	.7	4.8	2.1	0
26	1.3	.7	5.2	2.1	0
27	1.4	.7	5.6	2.1	0
28	1.5	.7	6.0	2.1	0
29	1.5	1.1	6.0	3.3	1
30	1.5	1.2	6.0	3.6	0
31	1.6	3.1	6.4	9.3	1
32	1.7	.6	6.8	1.8	0
33	1.7	.9	6.8	2.7	1
34	1.7	1.5	6.8	4.5	1
35	1.7	2.4	6.8	7.2	1
36	1.7	3.2	6.8	9.6	1
44	1.8	3.1	7.2	9.3	1
43	1.8	2.9	7.2	8.7	1
42	1.8	2.5	7.2	7.5	1
41	1.8	2.2	7.2	6.6	0
40	1.8	1.6	7.2	4.8	1
39	1.8	.7	7.2	2.1	0
38	1.8	.4	7.2	1.2	1
37	1.8	.1	7.2	.3	1
45	1.9	.6	7.6	2.4	0
46	1.9	.9	7.6	2.7	0
47	1.9	2.0	7.6	6.0	1
48	1.9	3.0	7.6	9.0	1
49	1.9	3.3	7.6	9.9	0
50	1.9	3.5	7.6	10.5	0
51	2.0	2.5	8.0	7.5	0
52	2.1	.1	8.4	.3	0
53	2.1	2.5	8.4	7.5	0
54	2.1	2.7	8.4	8.1	0
55	2.1	2.8	8.4	8.4	1
56	2.1	3.3	8.4	9.9	0
60	2.2	6.2	8.8	18.6	0
59	2.2	3.3	8.8	9.9	1
58	2.2	1.2	8.8	3.6	0
57	2.2	.6	8.8	2.4	1
61	2.3	1.3	9.2	3.9	1
62	2.3	3.4	9.2	10.2	0
63	2.3	5.1	9.2	15.3	1
64	2.3	6.2	9.2	18.6	0
65	2.3	6.3	9.2	18.9	1
66	2.4	3.0	9.6	9.0	1
67	2.5	3.0	10.0	9.0	1
68	2.5	3.6	10.0	10.8	0
69	2.5	3.7	10.0	11.1	1
70	2.5	4.2	10.0	12.6	1
75	2.6	4.4	10.4	13.2	1
74	2.6	4.3	10.4	12.9	1
73	2.6	4.2	10.4	12.6	1
72	2.6	3.7	10.4	11.1	0
71	2.6	3.6	10.4	10.8	0

A.2 Link Table

INDEX	NODE	LINKS		NO OF LINKS IFLAG	NO OF LINK PLOTED NOPLT
		1	2		
1		0	0	0	1
2		2	3	1	1
3		2	4	1	1
4		4	5	1	1
5		5	8	1	1
6		8	7	1	1
7		8	12	1	1
8		12	6	1	1
9		12	13	1	1
10		12	17	1	1
11		17	19	1	1
12		19	23	1	1
13		23	24	1	1
14		24	14	1	1
15		14	5	1	1
16		14	11	1	1
17		11	1	1	1
18		11	20	1	1
19		20	17	1	1
20		20	22	1	1
21		22	19	1	1
22		22	21	1	1
23		22	34	1	1
24		34	33	1	1
1		67	4032	59	3878
				194	3541
25		34	41	2	2
26		41	40	1	1
27		40	47	1	1
28		40	53	1	1
29		53	54	1	1
30		54	55	1	1
31		55	39	1	1
32		39	35	1	1
33		39	51	1	1
34		55	38	1	1
35		38	62	1	1
36		62	49	1	1
37		49	56	1	1
38		56	48	1	1
39		48	36	1	1
40		48	37	1	1
41		37	31	1	1
42		56	50	1	1
43		56	56	1	1
44		58	62	1	1
45		62	66	1	1
46		66	75	1	1
47		75	68	1	1
48		68	69	1	1
49		69	75	1	1
50		75	80	1	1
51		80	69	1	1
52		69	79	1	1
53		79	88	1	1
54		88	89	1	1
55		89	74	1	1
56		74	80	1	1
57		80	102	1	1
58		102	94	1	1
59		94	84	1	1
60		84	82	1	1
61		82	73	1	1
62		73	70	1	1
63		70	72	1	1
64		72	73	1	1
65		73	81	1	1
66		81	72	1	1
67		70	71	1	1
68		71	83	1	1
69		82	86	1	1
70		86	62	1	1
71		86	85	1	1
72		85	88	1	1
73		88	87	1	1
74		87	79	1	1
75		88	104	1	1
76		104	126	1	1

A.3 Command Table

INITIAL NETWORK

COMMANDS

CMSUR	UNITX(1)	UNITY(1)	COURDX(1)	COURDY(1)	NHOME	HOMINGS			
20	0	-1.1250	5.2308	-1.5000	15.6924	2	63	123	
19	0	3.2967	9.1667	13.1868	27.5000	2	144	122	
23	0	3.4690	9.1667	13.6758	27.5000	2	153	147	
8	0	3.6412	9.1667	14.5649	27.5000	2	163	161	
5	0	4.3303	9.1667	17.3210	27.5000	5	316	181	296 168 116
17	0	4.6748	9.1667	18.6991	27.5000	2	243	252	
6	0	6.0529	9.1667	24.2114	27.5000	2	411	412	
3	0	6.7419	9.1667	26.9676	27.5000	4	339	442	560 452
13	0	6.9141	9.1667	27.6566	27.5000	2	445	481	
4	0	7.0003	9.1667	28.0011	27.5000	2	450	449	
2	0	7.5171	9.1667	30.0682	27.5000	5	605	586	585 584 571
11	0	8.8951	9.1667	35.5805	27.5000	5	605	586	585 584 571
7	0	9.7564	9.1667	39.0257	27.5000	2	712	710	
16	0	12.1250	6.4679	48.5000	19.4038	2	764	765	
22	0	12.1250	4.4008	48.5000	13.2025	2	838	824	
1	0	12.1250	1.4150	48.5000	4.2450	2	781	772	
15	0	9.4354	-1.1667	37.7416	-1.5000	2	679	668	
9	0	9.2631	-1.1667	37.0526	-1.5000	2	679	668	
12	0	6.4209	-1.1667	25.6834	-1.5000	2	441	440	
21	0	6.3347	-1.1667	25.3369	-1.5000	2	426	419	
18	0	4.5260	-1.1667	18.1040	-1.5000	2	231	250	
10	0	3.4524	-1.1667	13.9698	-1.5000	2	171	170	
14	0	3.2341	-1.1667	12.9362	-1.5000	2	127	130	

A.4 Subordinate Table

INITIAL NETWORK				SUBORDINATES			
CMDSUB	UNITX(1)	UNITY(1)	COORDX(1)	COORDY(1)	NHOME	HOMINGNS	
3 1	-0.1250	1.0966	-0.5000	3.2697	2	33	29
3 2	-0.1250	2.5895	-0.5000	7.7685	2	76	90
5 25	-0.1250	2.8192	-0.5000	8.4575	3	1	70 47
3 35	-0.1250	3.1637	-0.5000	9.4910	2	39	35
3 3	-0.1250	3.8527	-0.5000	11.5582	2	127	130
5 31	-0.1250	4.0824	-0.5000	12.2472	2	38	48
4 1	-0.1250	4.3121	-0.5000	12.9362	2	38	48
2 1	-0.1250	4.4269	-0.5000	13.2208	2	38	48
3 4	-0.1250	4.6566	-0.5000	13.9698	2	66	67
5 24	-0.1250	5.9198	-0.5000	17.7595	3	1	70 194
5 22	-0.1250	6.0347	-0.5000	18.1040	3	1	70 194
5 23	-0.1250	6.1495	-0.5000	18.4484	3	1	70 194
5 2	-0.1250	7.6424	-0.5000	22.9273	2	112	122
5 21	-0.1250	8.1018	-0.5000	24.3054	2	65	97
3 5	-0.0238	9.1667	0.0951	27.5000	2	98	132
5 20	0.2822	9.1667	1.1286	27.5000	2	124	125
5 32	1.3157	9.1667	5.2629	27.5000	2	147	153
2 2	1.4880	9.1667	5.9519	27.5000	2	147	153
4 2	1.5741	9.1667	6.2964	27.5000	2	147	153
5 12	1.6325	9.1667	7.3300	27.5000	2	157	138
5 16	2.2631	9.1667	9.0526	27.5000	2	116	194
5 17	2.3493	9.1667	9.3971	27.5000	2	116	194
5 1	2.5215	9.1667	10.0861	27.5000	2	163	161
5 3	2.6938	9.1667	10.7752	27.5000	2	194	119
3 7	3.0383	9.1667	12.1532	27.5000	2	178	179
5 13	3.9857	9.1667	15.9430	27.5000	2	216	198
3 6	4.5025	9.1667	18.0101	27.5000	2	222	223
4 3	4.5886	9.1667	18.3546	27.5000	2	241	242
2 3	4.7609	9.1667	19.0436	27.5000	2	241	242
5 33	5.0193	9.1667	20.0772	27.5000	2	241	242
3 11	5.3638	9.1667	21.4552	27.5000	2	264	278
5 19	5.7945	9.1667	23.1778	27.5000	2	292	314
3 12	6.3974	9.1667	25.5895	27.5000	2	393	394
3 14	6.5696	9.1667	26.2785	27.5000	2	413	392
3 15	6.6558	9.1667	26.6230	27.5000	2	415	407
3 13	7.3448	9.1667	29.3792	27.5000	2	411	412
5 10	7.4309	9.1667	29.7237	27.5000	2	411	412
5 8	7.9477	9.1667	31.7908	27.5000	1	442	
5 35	8.2061	9.1667	32.8244	27.5000	2	450	449
2 5	8.2922	9.1667	33.1689	27.5000	2	450	449
3 24	8.6367	9.1667	34.5470	27.5000	2	461	462
3 22	9.2397	9.1667	36.9586	27.5000	2	460	504
3 23	9.4980	9.1667	37.9922	27.5000	2	480	539
3 25	9.5842	9.1667	38.3367	27.5000	2	503	525
5 9	9.9787	9.1667	39.7148	27.5000	1	560	
5 4	10.2732	9.1667	41.0928	27.5000	5	605	586 585 584 571
2 6	10.4455	9.1667	41.7819	27.5000	2	605	582
4 5	10.6177	9.1667	42.4709	27.5000	2	605	582
5 36	10.7039	9.1667	42.8154	27.5000	2	605	582
3 26	11.0484	9.1667	44.1935	27.5000	2	675	711
3 34	11.5652	9.1667	46.2606	27.5000	2	764	765
5 11	11.7374	9.1667	46.9497	27.5000	2	764	765
3 33	12.1250	8.5351	48.5000	25.6051	2	825	790
3 32	12.1250	8.0757	48.5000	24.2271	2	808	807
5 28	12.1250	7.3867	48.5000	22.1600	3	839	825 826
5 26	12.1250	7.2718	48.5000	21.8154	3	839	825 826
5 27	12.1250	7.1570	48.5000	21.4709	3	839	825 826
5 30	12.1250	6.8124	48.5000	20.4373	2	825	839
3 30	12.1250	5.7789	48.5000	17.3367	2	823	824
3 31	12.1250	5.6641	48.5000	16.9922	2	823	824
5 37	12.1250	5.2047	48.5000	15.6141	2	839	837
2 7	12.1250	5.0899	48.5000	15.2696	2	839	837
4 6	12.1250	4.9750	48.5000	14.9251	2	839	837
3 29	12.1250	4.7453	48.5000	14.2360	2	822	811
5 29	12.1250	4.0563	48.5000	12.1669	2	625	744
1 14	12.1250	3.9415	48.5000	11.8244	2	820	827
1 2	12.1250	3.8266	48.5000	11.4799	2	820	827
1 8	12.1250	3.7118	48.5000	11.1353	2	820	827
1 20	12.1250	3.5969	48.5000	10.7908	2	820	827
1 19	12.1250	3.4821	48.5000	10.4463	2	721	733
1 7	12.1250	3.3673	48.5000	10.1018	2	835	829
1 21	12.1250	3.2524	48.5000	9.7573	2	746	737
1 4	12.1250	3.1376	48.5000	9.4127	2	832	818
1 16	12.1250	3.0227	48.5000	9.0682	2	802	803
1 1	12.1250	2.9079	48.5000	8.7237	2	746	736
3 28	12.1250	2.7931	48.5000	8.3792	2	736	746
1 9	12.1250	2.4485	48.5000	7.3456	2	736	744

APPENDIX B SAMPLE PLOTS FROM NETPLT

TEST NETWORK--AUTOVON

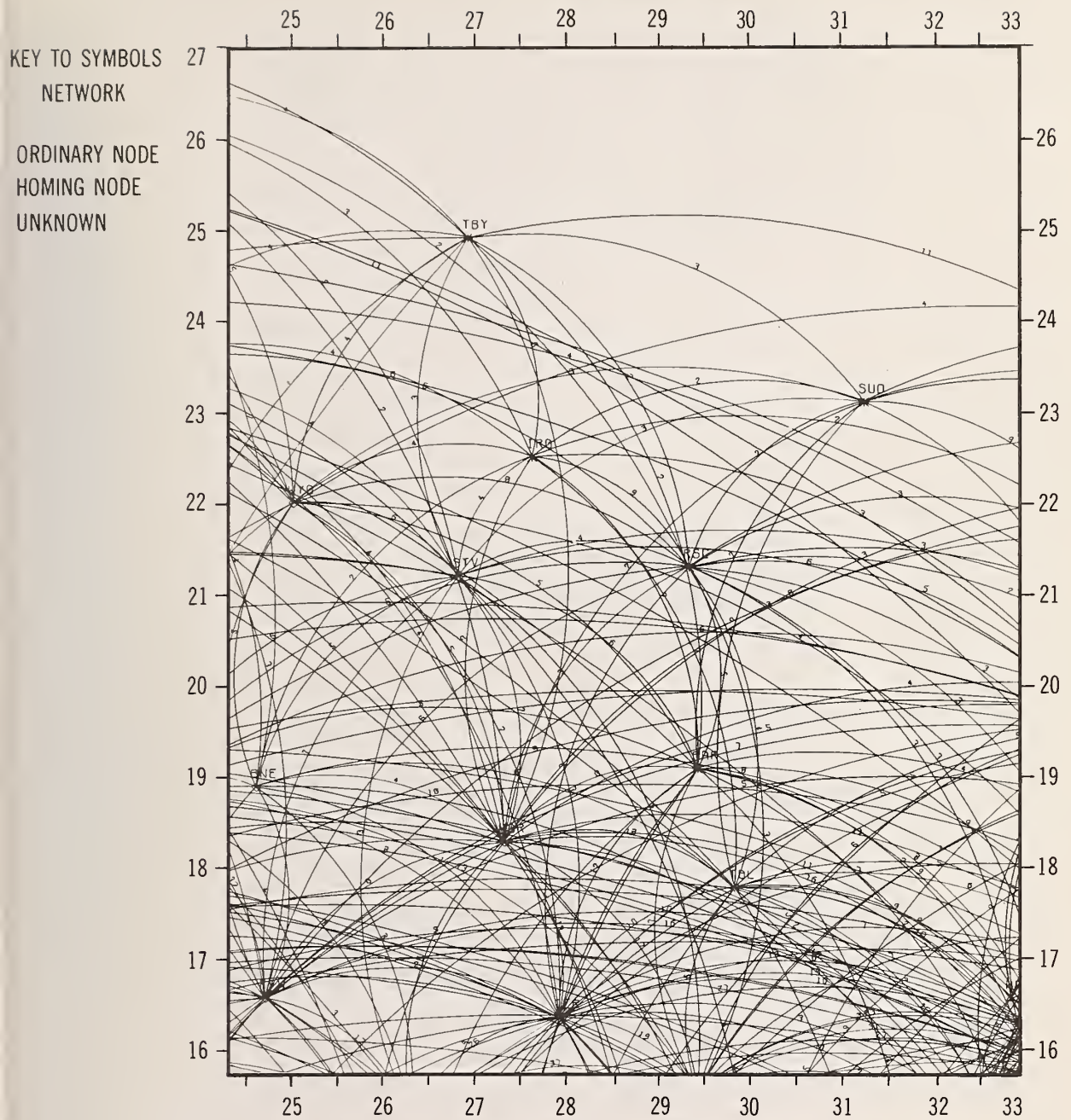


Fig. B2 Densely Connected Network (Autovon)

(Section of full drawing)


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000001      DIMENSION UNITX(900),UNITY(900),NODEN(900),HEAO(36),COORDX(900),
000002      ICODROY(900),RUFF(1100),NHM(5),LPTYPE(9),NCO(5),LL(5)
000003      COMMON/BRDR/XAXIS,YAXIS,TIC,HT,CX,CY,HEAO
000004      COMMON/ARC/ ICURV,XIP1,XIP2,YIP1,YIP2,IFLAG,DEG,NOPLT,IWRITE,OI
000005      IREAD = 5
000006      IWRITE = 6
000007      C      NOOES >NUMBER OF NODES FOR NETWORK.
000008      C      LINKS >NUMBER OF LINKS FOR NETWORK.
000009      C      ICURV SETS LINK TYPE. 1 MEANS DOWNWARD ARCS. 2 MEANS UPWARD ARCS.
000010      READ(IREAD,1000) NOOES ,LINKS ,ICURV
000011      1000 FORMAT(4I5)
000012      C      VARIABLES IN NEXT READ STATEMENT = PLOT PARAMETERS.
000013      C      NPLDT>ND. OF PLOTS FOR NETWORK AND ITS SUBSCRIBERS [1 OR MORE].
000014      C      XAXIS=LENGTH OF X AXIS IN INCHES.
000015      C      YAXIS=LENGTH OF Y AXIS IN INCHES.
000016      C      SCALEX=LENGTH OF X AXIS IN DATA UNITS.
000017      C      SCALEY=LENGTH OF Y AXIS IN DATA UNITS.
000018      C      PLOTX=X DIMENSION OF PLOTTER.
000019      C      PLOTY=Y DIMENSION OF PLOTTER.
000020      READ(IREAD,1001) NPLDT ,XAXIS,YAXIS,SCALEX,SCALEY,PLOTX,PLO
000021      ITY
000022      1001 FORMAT( 15,6(5X,F5.1))
000023      C      CALCULATE CONVERSION FACTORS CX, CY FOR AXES.
000024      CX = XAXIS/SCALEX
000025      CY = YAXIS/SCALEY
000026      CALL PLOTS(BUFF,1000,7)
000027      IF(NPLDT) 5030,5030,18
000028      5030 WRITE(IWRITE,5006)
000029      5006 FORMAT(16H ERROR IN NPLDT.)
000030      STOP
000031      18 NPL = NPLDT
000032      C      LPTYPE=1 MEANS PLOT NETWORK PLUS SUBSCRIBERS ON BORDER.
000033      C      LPTYPE=2 MEANS PLOT NETWORK ONLY.
000034      C      LPTYPE=3 MEANS PLOT AN OVERLAY WITH SUBSCRIBERS OR COMMANDERS ON
000035      C      BORDER.
000036      C      LPTYPE=4 MEANS PLOT AN OVERLAY WITH 4 OR 5 COMMANDERS AND/OR
000037      C      THEIR SUBORDINATES ON THE BORDER.
000038      READ(IREAD,1011)(LPTYPE(I),I=1,NPL)
000039      1011 FORMAT(10I5)
000040      XII = (PLOTX-XAXIS)/2
000041      YII = (PLOTY-YAXIS)/2.
000042      TIC = .05
000043      HT = .1
000044      DD 100 LJ=1,NPL
000045      XI = XII
000046      YI = YII
000047      CALL PLOT(XI,YI,-3)
000048      READ (IREAD,2001) HEAO
000049      2001 FORMAT ((12A6))
000050      WRITE(IWRITE,8)
000051      8 FORMAT(1H1)
000052      WRITE(IWRITE,2001) HEAO
000053      ITYPE = LPTYPE(LJ)
000054      CALL RORDER
000055      C      READ IN NODE NO. AND COORDINATES. CONVERT TO INCHES ON PLOTTER.
000056      IF(LJ-1) 33,33,34
000057      33 IF ( NOOES ) 5000,5000,3002
000058      5000 WRITE(IWRITE,5002)
000059      5002 FORMAT(4H DATA CARDS CONTAINING NOOES IS IN ERROR.)
000060      STOP
000061      3002 WRITE(IWRITE,1)
000062      1 FORMAT(20X,19HCOORDINATES OF NODE/16X,8H INITIAL,14X,6HINCHES/2X,5
000063      IHNDEN,4X,8HUNITX(1),2X,8HUNITY(1),2X,9HCOORDX(1),2X,9HCOORDY(1),2
000064      2X,5H TYPE)
000065      DO 10 I=1,NOOES
000066      C      NTYPE=0 MEANS NODE IS ORDINARY. NTYPE=1 MEANS NODE IS A SUBSCRIB
000067      C      ER HOMING. ENTRY OR EXIT
000068      READ(IREAD,1002) NODEN(I),UNITX(I),UNITY(I),NTYPE
000069      1002 FORMAT (15,30X,2F5.1,14X,11)
000070      COORDX(I) = UNITX(I)*CX
000071      COORDY(I) = UNITY(I)*CY
000072      XCOORD = COORDX(I)
000073      YCOORD = COORDY(I)
000074      IF(ITYPE-2) 14,14,10
000075      14 IF(NTYPE) 11,12,11
000076      11 L = 11
000077      GO TO 13
000078      12 L = 5
000079      13 FPN = NODEN(I)
000080      CALL SYMBOL(XCOORD,YCOORD,HT,L,0.,-1)
000081      CALL NUMBER(XCOORD-HT/2.,YCOORD+HT,HT,FPN,0.,-1)

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000082      WRITE(IWRITE,2) NOOEN(I),UNITX(I),UNITY(I),COORDX(I),COORDY(I),NTY
000083      IPE
000084      2 FORMAT(3X,14,5X,F5.1,3X,F5.1,8X,F5.1,6X,F5.1,6X,11)
000085      10 CONTINUE
000086      34 IF(ITYPE-2) 35,35,36
000087      35 OEG = 60.
000088      IF(LINKS )3030,3030,3020
000089      3030 WRITE(IWRITE,5003)
000090      5003 FORMAT(27H VALUES FOR LINKS IN ERROR.)
000091      STOP
000092      3020 WRITE(IWRITE,3)
000093      3 FORMAT(1H1,26X,SHNO OF,2X,11HNO OF LINKS/11X,13H      LINKS      ,3X,5
000094      1HLINKS,2X,11H PLOTTEO /2X,SHNOEX,3X,6HNOOE 1,2X,6HNOOE 2,3X,6H1
000095      2FLAG ,3X,7HNOPLT )
000096      O1 = 0.0
000097      O0 20 I=1,LINKS
000098      READ (IREAO,1003) IP1,IP2,IFLAG
000099      1003 FORMAT (5X,21S,48X,12)
000100      XIP1 = COORBX(IP1)
000101      XIP2 = COOROX(IP2)
000102      YIP1 = COORBY(IP1)
000103      YIP2 = COORDY(IP2)
000104      CALL PLTARC
000105      WRITE(IWRITE,4) I,IP1,IP2,IFLAG,NOPLT
000106      4 FORMAT(3X,14,5X,14,2X,14,6X,13,7X,13)
000107      20 CONTINUE
000108      36 IF(ITYPE-2) 3004,334,3004
000109      C NSUBS > NUMBER OF SUBSCRIBERS IN NETWORK.
000110      3004 READ(IREAO,1008) NSUBS
000111      1008 FORMAT(21S)
000112      IF(NSUBS ) 2030,2030,3040
000113      2030 WRITE(IWRITE,5004)
000114      5004 FORMAT(29H VALUE FOR NSUBS IS IN ERROR.)
000115      STOP
000116      3040 NSUM = 0
000117      IFLAG = 1
000118      WRITE(IWRITE,5)
000119      5 FORMAT(2X,6HCMOSUB,3X,8HUNITX(I),2X,8HUNITY(I),2X,9HCOORDX(I),2X,9
000120      HCOORDY(I),2X,5HNNHOME,2X,7HHOMINGS)
000121      IF(ITYPE-3) 62,62,63
000122      63 READ(IREAO,1007)(NCO(I),I=1,5)
000123      1007 FORMAT(51S)
000124      LL(1)=0
000125      LL(2)=1
000126      LL(3)=2
000127      LL(4)=6
000128      LL(5)=10
000129      62 L=11
000130      O1 = 0.5
000131      O0 30 I=1,4
000132      N = 11
000133      READ(IREAO,1004) K
000134      1004 FORMAT(1S)
000135      NSUM = NSUM+K
000136      O0 40 J =1,K
000137      READ(IREAO,1005) NCMO,NSUB,XUNIT,YUNIT,NHOME
000138      1005 FORMAT(21S, 25X, 2F10.5, 1S)
000139      XCOORD = XUNIT*CX
000140      YCOORD = YUNIT*CY
000141      FPN = NCMO
000142      FRN= NSUB
000143      IF(ITYPE-3) 65,64,65
000144      65 O0 60 IJ=1,5
000145      NC=NCO(IJ)
000146      IF(NC-NCMO) 60,61,60
000147      61 L=LL(IJ)
000148      GO TO 64
000149      60 CONTINUE
000150      WRITE(IWRITE,5007)
000151      5007 FORMAT(42H A COMMANDER-SUBORDINATE CARO IS IN ERROR.)
000152      64 GO TO (41,42,43,44),N
000153      41 XX = XCOORD-3*HT
000154      YY = YCOORD
000155      YJ = YY-HT-.05
000156      GO TO 45
000157      42 XX = XCOORD-HT/2.
000158      YY = YCOORD+HT*2+.05
000159      YJ = YY-HT-.05
000160      GO TO 45
000161      43 XX = XCOORD+HT
000162      YY = YCOORD
000163      YJ = YY-HT-.05
000164      GO TO 45
000165      44 XX = XCOORD-HT/2.
000166      YY = YCOORD-2*HT
000167      YJ = YY-HT-.05
000168      45 CALL SYMBOL(XCOORD,YCOORD,HT,L,0.,-1)

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000169      CALL NUMBER(XX,YY,HT,FPN,0.,-1)
000170      CALL NUMBER(XX,YJ,HT,FRN,0.,-1)
000171      IFLG = 1
000172      READ(IREAD,1006) (NHM(I),I=1,NHOME)
000173 1006 FORMAT(5I5)
000174      OO 50 IJ = 1,NHOME
000175      XIP1 = XCOORD
000176      YIP1 = YCOORD
000177      IP2 = NHM(IJ)
000178      XIP2 = COOROX(IP2)
000179      YIP2 = COORDY(IP2)
000180      IFLG = -1*IFLG
000181      IF(IFLG-1) 54,55,55
000182      55 TEMP = XIP1
000183      XIP1 = XIP2
000184      XIP2 = TEMP
000185      TEMP = YIP1
000186      YIP1 = YIP2
000187      YIP2 = TEMP
000188      54 CALL PLOT(XIP1,YIP1,3)
000189      CALL PLOT(XIP2,YIP2,2)
000190      50 CONTINUE
000191      WRITE(IWRITE,6) NCMO,NSUB,XUNIT,YUNIT,XCOORD,YCOORD,NHOME,(NHM(I),
000192      I=1,NHOME)
000193      6 FORMAT(2X,2I3,4F10.4,4X,I3,2X,5I5)
000194      40 CONTINUE
000195      30 CONTINUE
000196      IF(NSUB5-NSUM) 5040,334,5040
000197      5040 WRITE(IWRITE,5005)
000198      5005 FORMATE69H THERE IS AN ERROR BETWEEN NSUBS AND NUMBER OF SUBSCRIBE
000199      IR DATA CARDS.]
000200      334 CONTINUE
000201      C      HEADING
000202      XL = 216*.125
000203      POINT = (XAXIS-XL)/2
000204      PY = YAXIS+1.
000205      CALL SYMBOL(POINT,PY,.125,HEAD,0.,216)
000206      C      KEY TO SYMBOLS
000207      CALL SYMBOL(-3.0,YAXIS,.125,14HKEY TO SYMBOLS,0.,14)
000208      GO TO (B0,B0,B2,B3),IYPE
000209      B0 YY = YAXIS-.25
000210      CALL SYMBOL(-2.625,YY,HT,7HNETWORK,0.,7)
000211      YY = YY-.2
000212      CALL SYMBOL(-2.95,YY+HT/2,HT,5,0.,-1)
000213      CALL SYMBOL(-2.75,YY,HT,13HORDINARY NOOE,0.,13)
000214      YY = YY-.2
000215      CALL SYMBOL(-2.95,YY+HT/2,HT,11,0.,-1)
000216      CALL SYMBOL(-2.75,YY,HT,11HHOMING NOOE,0.,11)
000217      IF(IYPE-2)B2,335,B2
000218      B2 YY = YAXIS-.85
000219      CALL SYMBOL(-2.5,YY,HT,6HORDER,0.,6)
000220      YY = YY-.2
000221      CALL SYMBOL(-3.0,YY,HT,2HN1,0.,2)
000222      CALL SYMBOL(-2.75,YY,HT,13HCOMMANDER NO.,0.,13)
000223      YY = YY-.15*2
000224      CALL SYMBOL(-2.95,YY+HT/2,HT,11,0.,-1)
000225      CALL SYMBOL(-2.75,YY,HT,8HLOCATION,0.,8)
000226      GO TO 335
000227      B3 YY = YAXIS-1.60
000228      CALL SYMBOL(-2.5,YY,HT,6HORDER,0.,6)
000229      OO B9 IK=1,5
000230      YY = YY-.2
000231      NC = NCO(IK)
000232      FP = NC
000233      IF(NC) 90,B9,90
000234      90 CALL NUMBER(-3.0,YY,HT,FP,0.,-1)
000235      CALL SYMBOL(-2.75,YY,HT,13HCOMMANDER NO.,0.,13)
000236      YY = YY-.15
000237      CALL SYMBOL(-3.0,YY,HT,2HN2,0.,2)
000238      CALL SYMBOL(-2.75,YY,HT,15HSUBORDINATE NO.,0.,15)
000239      YY = YY-.15
000240      L = LL(IK)
000241      CALL SYMBOL(-2.95,YY+HT/2,HT,L,0.,-1)
000242      CALL SYMBOL(-2.75,YY,HT,8HLOCATION,0.,8)
000243      B9 CONTINUE
000244      335 XI = XAXIS
000245      YI = -YII
000246      CALL PLOT(XI,YI,-3)
000247      CALL PLOT(0.0,0.0,999)
000248      100 CONTINUE
000249      ENO

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000001      SUBROUTINE BOROR
000002      COMMON/RPOR/XAXIS,YAXIS,TIC,HT,CX,CY,HEAD
000003      C      BOTTOM X AXIS
000004      X = 0.0

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000005      K = XAXIS/CX
000006      S = K*CX
000007      OIF = XAXIS-S
000008      DO 10 I = 1,K
000009      DO 20 J = 1,2
000010      X = X+CX/2.
000011      CALL PLOT(X,0.,2)
000012      CALL PLOT(X,-TIC,2)
000013      CALL PLOT(X,0.0,3)
000014 20 CONTINUE
000015      XX = X-HT/2.
000016      FPN = X/CX
000017      YY = -2*TIC-HT
000018      CALL NUMBER(XX, YY,HT,FPN,0.,-1)
000019 10 CALL PLOT(X,0.0,3)
000020      IF(OIF .LE. 0.) GO TO 31
000021      CALL PLOT(XAXIS,0.0,2)
000022 31 X = XAXIS
C 000023      RIGHT Y AXIS
000024      Y = 0.0
000025      K = YAXIS/CY
000026      S = K*CY
000027      OIF = YAXIS-S
000028      DO 30 I = 1,K
000029      DO 40 J = 1,2
000030      Y = Y+CY/2.
000031      CALL PLOT(X,Y,2)
000032      XX = X+TIC
000033      CALL PLOT(XX,Y,2)
000034      CALL PLOT(X,Y,3)
000035 40 CONTINUE
000036      XX = X+2*TIC
000037      FPN = Y/CY
000038      CALL NUMBER(XX,Y,HT,FPN,0.,-1)
000039 30 CALL PLOT(X,Y,3)
000040      IF(OIF .LE. 0.) GO TO 51
000041      Y = YAXIS
000042      CALL PLOT(X,Y,2)
C 000043      TOP X AXIS
000044 51 K = XAXIS/CX
000045      Y = YAXIS
000046      S = K*CX
000047      OIF = XAXIS-S
000048      IF(OIF .LE. 0.) GO TO 61
000049      X = XAXIS-OIF
000050      CALL PLOT(X,Y,2)
000051      YY = Y+TIC
000052      CALL PLOT(X,YY,2)
000053      CALL PLOT(X,Y,3)
000054 61 DO 50 I = 1,K
000055      DO 60 J = 1,2
000056      X = X-CX/2
000057      CALL PLOT(X,Y,2)
000058      YY = Y+TIC
000059      CALL PLOT(X,YY,2)
000060      CALL PLOT(X,Y,3)
000061 60 CONTINUE
000062      XX = X-HT/2
000063      YY = Y+2*TIC
000064      FPN = X/CX
000065      CALL NUMBER(XX,YY,HT,FPN,0.,-1)
000066 50 CALL PLOT(X,Y,3)
000067      X = 0.0
C 000068      LEFT Y AXIS
000069      K = YAXIS/CY
000070      S = K*CY
000071      OIF = YAXIS-S
000072      IF(OIF .LE. 0.) GO TO 81
000073      Y = YAXIS-OIF
000074      CALL PLOT(0.0,Y,2)
000075      CALL PLOT(-TIC,Y,2)
000076      CALL PLOT(0.0,Y,3)
000077 81 DO 70 I = 1,K
000078      DO 80 J = 1,2
000079      Y = Y-CY/2
000080      CALL PLOT(0.0,Y,2)
000081      CALL PLOT(-TIC,Y,2)
000082      CALL PLOT(0.0,Y,3)
000083 80 CONTINUE
000084      FPN = Y/CY
000085      XX = -2*TIC-HT
000086      YY = Y-HT/2
000087      CALL NUMBER(XX,YY,HT,FPN,0.,-1)
000088 70 CALL PLOT(0.,Y,3)
000089      RETURN
000090      END

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000001      SUBROUTINE PLTARC
000002      CDMMDN/ARC/ 1CURV,XIP1,XIP2,YIP1,YIP2,IFLAG,DEG,NDPLT,IWRITE,DI
C      FLAG IDIR=-1 MEANS LINK IS DRAWN COUNTERCLOCKWISE FROM NDDE 1 TO
C      NDDE 2.
C      FLAG IDIR=1 MEANS LINK IS DRAWN CLOCKWISE FROM NDDE 2 TO NDDE 1.
000006      IF(1CURV-1) 250,250,450
000007      250 IF( XIP1-XIP2 ) 265,270,275
000008      265 TEMP = XIP1
000009      XIP1 = XIP2
000010      XIP2 = TEMP
000011      TEMP = YIP1
000012      YIP1 = YIP2
000013      YIP2 = TEMP
000014      IDIR = 1
000015      GO TO 280
000016      450 IF( XIP1-XIP2 ) 475,470,465
000017      465 TEMP = XIP1
000018      XIP1 = XIP2
000019      XIP2 = TEMP
000020      TEMP = YIP1
000021      YIP1 = YIP2
000022      YIP2 = TEMP
000023      IDIR = 1
000024      GO TO 280
000025      470 IF( YIP1-YIP2 ) 475,475,465
000026      475 IDIR = -1
000027      GO TO 280
000028      270 IF( YIP1-YIP2 ) 265,275,275
000029      275 IDIR = -1
000030      280 DIST = SQRT((XIP1-XIP2)**2+(YIP1-YIP2)**2)
000031      IF(1CURV-1) 290,290,291
000032      291 A = (ASIN((YIP2-YIP1)/DIST))*180./3.1415
000033      GO TO 292
000034      290 A = (ASIN((YIP1-YIP2)/DIST))*180./3.1415
000035      292 GAMA = DEG/2.
000036      DMEG = 90.-GAMA
000037      DMEGR = DMEG*3.1415/180.
000038      DIST2 = DIST/2.
000039      R = DIST2/COS(DMEGR)
000040      IF(1CURV-1) 260,260,460
000041      460 B1 = A+DMEG+180.
000042      GO TO 261
000043      260 B1 = A+DMEG
000044      261 B2 = B1+DEG
000045      IF ( IDIR-1 ) 278,276,276
000046      276 CALL CIRCLE(XIP2,YIP2,B2,B1,R,R,DI)
000047      GO TO 279
000048      278 CALL CIRCLE(XIP1,YIP1,B1,B2,R,R,DI)
000049      279 D = .10
000050      IND = IFLAG
000051      NDPLT = 1
000052      IF(IND-1)200,200,201
000053      201 IND = IND-1
000054      GAMAR = GAMA*3.1415/180.
000055      AM = DIST2*TAN(GAMAR/2.)
000056      DD 295 JJ = 1,IND
000057      IDIR = -1*IDIR
000058      AN = D+AM
000059      IF(AN-DIST2) 283,283,281
000060      283 R2 = (AN**2 + DIST2**2)/(2.*AN)
000061      IF(R2-DIST2) 281,282,282
000062      282 PHI = (ASIN(DIST2/R2))*180./3.1415
000063      T1 = B1+GAMA-PHI
000064      T2 = T1+2.*PHI
000065      WRITE(IWRITE,6002) JJ,PHI,T1,T2
000066      6002 FORMAT(9X, 14,3F10.4)
000067      GO TO 285
000068      281 NDPLT = JJ
000069      GO TO 200
000070      285 IF ( IDIR-1 ) 287,286,286
000071      286 CALL CIRCLE(XIP2,YIP2,T2,T1,R2,R2,DI)
000072      GO TO 288
000073      287 CALL CIRCLE(XIP1,YIP1,T1,T2,R2,R2,DI)
000074      288 D = D+.10
000075      295 CONTINUE
000076      NDPLT = IND+1
000077      200 RETURN
000078      END

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000001      COMMON /ND/ YCOORD(1000), XCOORD(1000), NUM (1000),
000002      1 ISPEC(1000), NODES
000003      COMMON /LK/ ITRANS(1100), IREC(1100),          IDUP(1100), IND
000004      COMMON /CMDR/ ICOM(500), ISUB(500), IHOMF1(500), IHOMF2(500), NS
000005      COMMON /ECOM/ IPSUB(500), AVX(500), AVY(500), IZON2(500), IZON4(500),
000006      1 IZON6(500), IZON8(500),
000007      2 IHOM(5), YLEFF(200), XTOP(200), YRITE(200),
000008      3 XBOTOM(200), IPT, NCOM, NSCRIP, IRLANK, IOUT,L
000009      DIMENSION ICONN(1000), ISTAT(1100), ISTACK(100), IPNT(1100),
000010      1 MULNKS(1100)
000011      IOUT = 0
000012      IFWIND 0
000013      READ(R), NODES,(YCOORD(I), XCOORD(I), IBUFF,NUM(I), I=1,NODES)
000014      READ(3), IND,( IBUFF, IBUFF, ITRANS(I), IBUFF, IREC(I),
000015      1 IBUFF, IDUP(I), MULNKS(I), I=1,IND)
000016      PRINT 15, (I, NUM(I),XCOORD(I),YCOORD(I),I=1,NODES)
000017      15 FORMAT(1H1, 23X, 'ORIGINAL NODE TABLE'//
000018      1 2X, 'ID.', 4X, 'NODE NO.', 5X, 'X COORD.', 3X, 'Y COORD.'//
000019      2 (1X, I4, 7X, I4, 7X, F6.1, 2X, F6.1))
000020      PRINT 5
000021      5 FORMAT(1H1, 23X, 'ORIGINAL LINK TABLE'//)
000022      PRINT 201
000023      PRINT 202, (I, MULNKS(I), ITRANS(I), IREC(I), IDUP(I), I=1,IND)
000024      C      SORT NODES ON MINOR SORT Y ALTERNATING THE ORDER FOR SUCCESSIVE X'S.
000025      C      NODES ARE ASSUMED TO BE IN ASCENDING SORT ORDER ON X AND Y.
000026      J = 1
000027      500 TEMP = XCOORD(J)
000028      DO 510 I=J,NODES
000029      IREG = 1
000030      IF(XCOORD(I) .NE. TEMP) GO TO 520
000031      510 CONTINUE
000032      GO TO 530
000033      520 TEMP = XCOORD(IREG)
000034      DO 540 I=IREG,NODES
000035      K = I
000036      IF(XCOORD(I) .NE. TEMP) GO TO 550
000037      540 CONTINUE
000038      J = K+1
000039      GO TO 551
000040      550 J = K
000041      551 IEND = J-1
000042      IF(IEND .EQ. IREG) GO TO 570
000043      C      INVERT RECORDS.
000044      L = IREG
000045      554 I=IEND
000046      TEMP1 = YCOORD(IEND)
000047      TEMP2 = YCOORD(IEND)
000048      ITEMP = NUM(IEND)
000049      553 XCOORD(L) = YCOORD(M-1)
000050      YCOORD(L) = YCOORD(M-1)
000051      NUM(L) = NUM(M-1)
000052      M = M-1
000053      IF(M .LT. L) GO TO 552
000054      GO TO 553
000055      552 YCOORD(L) = TEMP1
000056      YCOORD(L) = TEMP2
000057      NUM(L) = ITEMP
000058      L = L+1
000059      IF(L .LT. IEND) GO TO 554
000060      C      ADJUST NODES IN LINK TABLE.
000061      ITERM = IREG + IEND
000062      556 DO 600 I=1,IND
000063      IF(ITRANS(I).GE.IREG.AND.ITRANS(I).LE.IEND) ITRANS(I) = ITERM -
000064      1 ITRANS(I)
000065      IF(IREC(I).GE. IREG.AND.IREC(I).LE.IEND) IREC(I)=ITERM-
000066      1 IREC(I)
000067      600 CONTINUE
000068      570 IF(J .GE. NODES) GO TO 530
000069      GO TO 520
000070      C      TRACE NETWORK FOR REORDERING LINKS.
000071      C      FIND CONNECTIVITY OF NODES.
000072      530 DO 30 I=1,IND
000073      30 ISTAT(I) = 'OUT'
000074      DO 31 I=1,NODES
000075      31 ICONN(I) = 0

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000076      DO 32 I=1,IND
000077      J = ITRANS(I)
000078      IF(J .GT. NODES) GO TO 1000
000079      ICONN(J) = ICONN(J) + 1
000080      J = IREC(I)
000081      IF(J .GT. NODES) GO TO 1000
000082      32 ICONN(J) = ICONN(J) + 1
000083      C      COUNT NO. OF NODES WITH 0 CONNECTIVITY.
000084      IJUMP = 0
000085      DO 34 I = 1,NODES
000086      IF(ICONN(I) .EQ. 0) IJUMP = IJUMP + 1
000087      34 CONTINUE
000088      PRINT 105, IJUMP
000089      105 FORMAT(2Y, I5, 2X, 'NODES HAVE ZERO CONNECTIVITY. '//)
000090      ICNT = 0
000091      IP = 0
000092      IL = 0
000093      40 IFLAG = 0
000094      ICNT = ICNT + 1
000095      C      LOOK FOR A STARTING NODE - CONNECTIVITY GREATER THAN 0.
000096      DO 41 I= 1,NODES
000097      IF(ICONN(I) .EQ.0) GO TO 41
000098      J = I
000099      GO TO 42
000100      41 CONTINUE
000101      PRINT 106
000102      106 FORMAT(2X, 'ERROR - NO TERMINAL NODE FOUND. LINK PRESENT THAT HAS
000103      1 NOT BEEN TRACED.')
000104      PRINT 500, (I, ICONN(I), I=1,NODES)
000105      500 FORMAT(7(5X, I5, 2X, I5))
000106      STOP
000107      C      START TRACING TREE.
000108      42 IP = IP + 1
000109      ISTACK(IP) = J
000110      46 DO 43 I=1,IND
000111      IF(ISTAT(I) .NE. 'OUT') GO TO 43
000112      IF(ITRANS(I) .EQ. J) GO TO 44
000113      IF(IREC(I) .NE. J) GO TO 43
000114      K = ITRANS(I)
000115      ITRANS(I) = IREC(I)
000116      IREC(I) = K
000117      GO TO 45
000118      44 K = IREC(I)
000119      45 ISTAT(I) = 'IN'
000120      ICONN(J) = ICONN(J) - 1
000121      ICONN(K) = ICONN(K) - 1
000122      J = K
000123      IL = IL + 1
000124      IPNT(IL) = I
000125      GO TO 42
000126      43 CONTINUE
000127      C      END OF A PATH REACHED.
000128      C      TRACE BRANCH BACKWARDS TO FIRST BRANCHING NODE.
000129      47 J = ISTACK(IP)
000130      IF(ICONN(J) .GT. 0) GO TO 46
000131      IP = IP - 1
000132      IF(IP .LE. 0) GO TO 50
000133      GO TO 47
000134      C      NETWORK IS COMPLETELY TRACED. SEE IF THERE IS A DISCONNECTED SUBNETWORK.
000135      50 CONTINUE
000136      C 50 PRINT 51, ICNT
000137      C 51 FORMAT(1H1, 2Y, 'CONNECTED SUBNETWORK ', I3// 15X, 'LINK NO.', 5X,
000138      C 1 'TRANSMITTER', 5X, 'RECEIVER'//)
000139      NO = 0
000140      DO 52 I=1,IND
000141      IF(ISTAT(I) .EQ. 'OUT') IFLAG = 1
000142      IF(ISTAT(I) .NE. 'IN') GO TO 52
000143      ISTAT(I) = 'USED'
000144      NO = NO + 1
000145      52 CONTINUE
000146      IF(IFLAG .EQ. 1) GO TO 40
000147      51 FORMAT(2X, 'THERE ARE ', I3, ' SUBNETWORKS. '//)
000148      PRINT 51, ICNT
000149      C      SORT LINKS TO BE PLOTTED IN MAIN TABLE.
000150      910 DO 920 I=1,IL
000151      ITEMP1 = ITRANS(I)
000152      ITEMP2 = IREC(I)
000153      ITEMP3 = IDUP(I)
000154      ITEMPN = NULNKS(I)
000155      J = IPNT(I)
000156      ITRANS(I) = ITRANS(J)
000157      IREC(I) = IREC(J)
000158      IDUP(I) = IDUP(J)
000159      NULNKS(I) = NULNKS(J)

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000160      ITRANS(J) = ITEMPT
000161      IREC(J) = ITEMPR
000162      IDUP(J) = ITEMPO
000163      NULNKS(J) = ITEMPO
000164      L = I+1
000165      IF(L .GT. IL) GO TO 920
000166      DO 930 K=L,IL
000167      IF(IPNT(K) .EQ. I) IPNT(K) = J
000168 930 CONTINUE
000169 920 CONTINUE
000170      IND = IL

000171      CALL SUBSRB
000172      PRINT FINAL NODE AND LINK TABLE
000173      PRINT 300, (I, NUM(I), XCOORD(I), YCOORD(I), ISPEC(I), I=1, NODES)
000174 300 FORMAT(1H1,16X, 'FINAL NODE TABLE'// 2X, 'NO.',
000175      1 4X, 'NODE NO.', 5X, 'X COORD.', 3X, 'Y COORD.', 13X, 'HOMING NODE'//
000176      2 (1X, I4, 7X, I4, 7X, F6.1, 2X, F6.1, 18X, I1))
000177      PRINT 400
000178 400 FORMAT(1H1, 43X, 'FINAL LINK TABLE'//)
000179      PRINT 201
000180 201 FORMAT(15X, 'LINK NO', 12X, 'TRANSMITTING NODE', 23X,
000181      1 'RECEIVING NODE', 24X, 'NO. OF LINKS'//)
000182      PRINT 202, (I, NULNKS(I), ITRANS(I), IREC(I), IDUP(I), I=1, IND)
000183 202 FORMAT((2X, I4, 12X, I4, 19X, I4, 36X, I4, 35X, I4))
000184      C WRITE(3, 960) (NUM(I), XCOORD(I), YCOORD(I), ISPEC(I), I=1, NODES)
000185 960 FORMAT(15, 30X, 2F5.1, 14X, I1, 15X, I5)
000186      WRITE(3, 970) (NULNKS(I), ITRANS(I), IREC(I), IDUP(I), I=1, IND)
000187 970 FORMAT(3I5, 48X, I2, 5X, I5)
000188      CALL SUB2
000189      STOP
000190 1000 PRINT 1001, J
000191 1001 FORMAT(2X, 'NODE ', I5, ' NOT FOUND IN NODE TABLE.')
000192      STOP
000193      END

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000001      SUBROUTINE SUBSRB
000002      COMMON /ND/ XCOORD(1000), YCOORD(1000), NUM (1000),
000003      1 ISPEC(1000), NODES
000004      COMMON /CMDR/ ICOM(500), JSUB(500), IHOME1(500), IHOME2(500), NS
000005      COMMON /ECON/ IPSUB(500), AVX(500), AVY(500), IZON2(500), IZON4(500),
000006      1 IZON6(500), IZON8(500),
000007      2 IHOME(5), YLEFT(200), XTOP(200), YRITE(200),
000008      3 XBOTOM(200), IPT, NCOM, NSCPIR, IBLANK, IOUT, L
000009      DIMENSION ITEM2(25), ITEM4(25), ITEM6(25), ITEM8(25)
000010      DIMENSION NAMECD(25)
000011      DATA IBLANK/ 6H
000012      READ (8), NS, (ICOM(I), ISUB(I), BUFF, BUFF, IHOME1(I), BUFF, BUFF,
000013      1 IHOME2(I), BUFF, I=1, NS)
000014      C TRANSLATE HOMINGS TO REORDERED SEQUENCE NO. FOR NODES.
000015      C MARK NODES THAT ARE HOMINGS
000016      DO 11 I=1, NODES
000017      11 ISPEC(I) = 0
000018      DO 1 I=1, NS
000019      J=IHOME1(I)
000020      DO 2 K=1, NODES
000021      IF(J .NE. NUM(K)) GO TO 2
000022      IHOME1(I) = K
000023      ISPEC(K) = 1
000024      GO TO 3
000025      2 CONTINUE
000026      WRITE(IOUT, 1000) J
000027 1000 FORMAT(2X, 32H CANNOT FIND TRANSLATION FOR NODE, I4)
000028      STOP
000029      3 J=IHOME2(I)
000030      IF(J .EQ. -1) GO TO 1
000031      DO 4 K=1, NODES
000032      IF(J .NE. NUM(K)) GO TO 4
000033      IHOME2(I) = K
000034      ISPEC(K) = 1
000035      GO TO 1
000036      4 CONTINUE
000037      WRITE(IOUT, 1000) J
000038      STOP
000039      1 CONTINUE
000040      RETURN
000041      ENTRY SUB2
000042      C *****
000043      C CONSTANTS FOR PLOT

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000044      XUNITS = 12.0
000045      YUNITS = 9.0
000046      XIN = 48.0
000047      YIN = 27.0
000048      BORDIN = 0.5
000049      *****
000050      C      WRITE(IOUT,340)
000051      340  FORMAT(1H1, 36X, 'INITIAL SUBSCRIBER TABLE'/)
000052      WRITE(IOUT,201)
000053      201  FORMAT(7X,'COMMANDER',3X,'SUBSCRIBER',12X,'HOMEING 1',24X,
000054      1 'HOMEING 2'//)
000055      WRITE(IOUT,202) (I, ICOM(I), ISUB(I), IHOME1(I), IHOME2(I),I=1,NS)
000056      202  FORMAT((2X, I3, 4X, A3, 10X, A3, 17X, I4, 28X, I4))
000057      NAMEPT = 0
000058      NPS = 0
000059      NCOM = IBLANK
000060      NSCRIB = IBLANK
000061      C      SET UP SUBSCRIBER TABLE WITH AV. X AND AV. Y VALUES OF HOMINGS AS THE
000062      C      REPRESENTATIVE POINTS.
000063      C      SET UP A TABLE WITH ALPHA NAMES OF COMMANDERS.
000064      DO 10 I=1,NS
000065      L = IHOME1(I)
000066      X1 = XCOORD(L)
000067      Y1 = YCOORD(L)
000068      IF(ICOM(I) .EQ. NCOM) GO TO 5
000069      C      NEW SUBSCRIBER
000070      NCOM = ICOM(I)
000071      NAMEPT = NAMEPT + 1
000072      NAMECD(NAMEPT) = NCOM
000073      GO TO 6
000074      5  IF(ISUB(I) .EQ. NSCRIB) GO TO 7
000075      6  NSCRIB = ISUB(I)
000076      IF(NPS .EQ. 0) GO TO 8
000077      AVX(NPS) = TX/CNT
000078      AVY(NPS) = TY/CNT
000079      8  NPS = NPS + 1
000080      TX = 0.0
000081      TY = 0.0
000082      CNT = 0.0
000083      IPSUB(NPS) = I
000084      7  TX = TX + X1
000085      TY = TY + Y1
000086      CNT = CNT + 1.0
000087      IF(IHOME2(I) .EQ. -1) GO TO 10
000088      L = IHOME2(I)
000089      X1 = XCOORD(L)
000090      Y1 = YCOORD(L)
000091      TX = TX + X1
000092      TY = TY + Y1
000093      CNT = CNT + 1.0
000094      10  CONTINUE
000095      AVX(NPS) = TX/CNT
000096      AVY(NPS) = TY / CNT
000097      C      SORT SUBSCRIBER TABLE ON AV. X AND AV. Y VALUES
000098      J = NPS - 1
000099      DO 83 I=1,J
000100      LPT = IPSUB(I)
000101      TAVX = AVX(I)
000102      TAVY = AVY(I)
000103      K = I+1
000104      DO 84 L = K,NPS
000105      IF(AVX(L) - TAVX) 85, 86, 84
000106      86  IF(AVY(L) - TAVY) 85, 84, 84
000107      85  TAVX2 = TAVX
000108      TAVY2 = TAVY
000109      LPT2 = LPT
000110      TAVX = AVX(L)
000111      TAVY = AVY(L)
000112      LPT = IPSUB(L)
000113      AVX(L) = TAVX2
000114      AVY(L) = TAVY2
000115      IPSUB(L) = LPT2
000116      84  CONTINUE
000117      IPSUB(I) = LPT
000118      AVX(I) = TAVX
000119      AVY(I) = TAVY
000120      83  CONTINUE
000121      PRINT 2000, (I,IPSUB(I), AVX(I), AVY(I), I=1,NPS)
000122      2000  FORMAT(1H1, 2X, 'POINTER TO SUBSCRIBERS', 2X, 'AVER. X', 2X,
000123      1 'AVER. Y' / (3X, I3,6X,I3,13X,F5.2, 3X, F5.2))
000124      C      COLLECT SUBSCRIBERS IN APPROPRIATE ZONES.
000125      C      THE ZONE IS DETERMINED BY FINDING THE SHORTEST DISTANCE FROM THE
000126      C      SUBSCRIBER TO ITS AVERAGE HOMING POINT, ASSUMING THE SUBSCRIBER LIES
000127      C      ON THE HORIZONTAL OR VERTICAL LINE WITH THE AVERAGE HOMING POINT.
000128      C      EQUATIONS FOR THE DIVIDING LINES IN THE CORNERS ARE AS FOLLOWS -
000129      C      BETWEEN ZONE 2 AND ZONE A -

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000130      X = Y      OR      Y = X
000131      BETWEEN ZONE 2 AND ZONE 4 -
000132      X = 27 - Y      OR      Y = -X + 27
000133      BETWEEN ZONE 4 AND ZONE 6 -
000134      48 - X = 27 - Y      OR      Y = X - 21
000135      BETWEEN ZONE 6 AND ZONE 8 -
000136      48 - X = Y      OR      Y = -X + 48
000137      NOTE - THE VARIABLES ARE MEASURED IN INCHES.
000138      DELTA = XIN - YIN
000139      INPXUN = XIN / XUNITS
000140      INPYUN = YIN / YUNITS
000141      IZ2 = 0
000142      IZ4 = 0
000143      IZ6 = 0
000144      IZ8 = 0
000145      C      COMPUTE BOUNDARY VALUES FOR X ALONG SIDE BORDERS
000146      C      THE MAX. VALUE = ONE HALF THE Y DIMENSION IN INCHES.
000147      XMAX = (YIN / 2) * (XUNITS / XIN)
000148      XMIN = XUNITS - XMAX
000149      DO 12 I=1,NPS
000150      IF(AVX(I) - XMAX) 13, 13, 14
000151      13 IF(AVY(I) - YUNITS/2) 15, 16, 16
000152      C      POINTS FALL IN ZONE 2 OR ZONE 8.
000153      C      DETERMINE THE LOCATION RELATIVE TO THE DIAGONAL.
000154      15 Y = AVX(I) * INPXUN
000155      IF(AVY(I) * INPYUN - Y) 17, 18, 18
000156      17 IZ8 = IZ8 + 1
000157      IZON8(IZ8) = I
000158      GO TO 12
000159      18 IZ2 = IZ2 + 1
000160      IZON2(IZ2) = I
000161      GO TO 12
000162      C      POINTS FALL IN ZONE 2 OR ZONE 4.
000163      C      DETERMINE THE LOCATION RELATIVE TO THE DIAGONAL.
000164      16 Y = YIN - AVX(I) * INPXUN
000165      IF(AVY(I) * INPYUN - Y) 19, 19, 20
000166      20 IZ4 = IZ4 + 1
000167      IZON4(IZ4) = I
000168      GO TO 12
000169      14 IF(AVX(I) - XMIN) 21, 28, 28
000170      21 IF(AVY(I) - YUNITS / 2) 17, 20, 20
000171      28 IF(AVY(I) - YUNITS/2) 33, 36, 36
000172      C      POINTS FALL IN ZONE 6 OR ZONE 8.
000173      C      DETERMINE THE LOCATION RELATIVE TO THE DIAGONAL.
000174      33 Y = XIN - AVX(I) * INPXUN
000175      IF(AVY(I) * INPYUN - Y) 17, 35, 35
000176      35 IZ6 = IZ6 + 1
000177      IZON6(IZ6) = I
000178      GO TO 12
000179      C      POINTS FALL IN ZONE 4 OR ZONE 6.
000180      C      DETERMINE THE LOCATION RELATIVE TO THE DIAGONAL.
000181      36 Y = AVX(I) * INPXUN - DELTA
000182      IF(AVY(I) * INPYUN - Y) 35, 35, 20
000183      12 CONTINUE
000184      410 FORMAT(2(4X, I3, 2X, I3))
000185      C      COMPUTE NORMAL DISTRIBUTION AROUND BORDER..
000186      TOTDIS = 2 * (YIN + XIN + 4*BORDIN)
000187      DINT = TOTDIS / NPS
000188      CY = YUNITS / YIN
000189      CX = XUNITS / XIN
000190      DINTX = DINT * CX
000191      IYL = 0
000192      IXT = 0
000193      IYR = 0
000194      DINTY = DINT * CY
000195      IYB = 0
000196      XLEFT = (-BORDIN) * CX
000197      YTOP = (YIN + BORDIN) * CY
000198      XRITE = (XIN + BORDIN) * CX
000199      YBOTOM = (-BORDIN) * CY
000200      C      COMPUTE COORDINATES FOR LEFT BORDER.
000201      CNSTNT = YBOTOM
000202      CNT = 0.0
000203      COORD = CNSTNT
000204      37 IYL = IYL + 1
000205      YLEFT(IYL) = COORD
000206      CNT = CNT + 1.0
000207      COORD = CNSTNT + CNT * DINTY
000208      IF(COORD - YTOP) 37, 38, 38
000209      C      COMPUTE COORDINATES FOR TOP BORDER.
000210      38 DIFF = (COORD - YTOP) * CX/CY
000211      CNSTNT = XLEFT + DIFF
000212      CNT = 0.0
000213      COORD = CNSTNT
000214      39 IXT = IXT + 1
000215      XTOP(IXT) = COORD

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000216      CNT = CNT + 1.0
000217      COORD = CNSTNT + CNT * DINTX
000218      IF(COORD - XRITE) 39, 40, 40
000219      C      COMPUTE COORDINATES FOR RIGHT BORDER.
000220      40      DIFF = (COORD - XRITE) * CY/CX
000221      CNSTNT = YTOP - DIFF
000222      CNT = 0.0
000223      COORD = CNSTNT
000224      41      IYR = IYR + 1
000225      YRITE(IYR) = COORD
000226      CNT = CNT + 1.0
000227      COORD = CNSTNT - CNT * DINTY
000228      IF(COORD - YBOTOM) 42, 42, 41
000229      C      COMPUTE COORDINATES FOR BOTTOM BORDER.
000230      42      DIFF = (YBOTOM - COORD) * CX/CY
000231      CNSTNT = XRITE - DIFF
000232      CNT = 0.0
000233      COORD = CNSTNT
000234      43      IXB = IXB + 1
000235      XBOTOM(IXB) = COORD
000236      CNT = CNT + 1.0
000237      COORD = CNSTNT - CNT * DINTX
000238      IF(COORD - XLEFT) 44, 44, 43
000239      C      END OF SUBSCRIBER COORDINATES ASSIGNMENT.
000240      44      IF(NPS, NE. (IYL+IXT+IYR+IXB)) IXB = IXB - 1
000241      IF(NPS, NE. (IYL+IXT+IYR+IXB)) STOP
000242      C      FIND DEVIATIONS FROM NORM FOR EACH SIDE.
000243      IDEV2 = IZ2 - IYL
000244      IDEV4 = IZ4 - IXT
000245      IDEV6 = IZ6 - IYR
000246      IDEV8 = IZ8 - IXB
000247      PRINT 52, IYL, IXT, IYR, IXB
000248      52      FORMAT(2X, 'NORMAL DISTRIBUTION IS ', 4I5)
000249      PRINT 53, IDEV2, IDEV4, IDEV6, IDEV8
000250      53      FORMAT(2X, 'DEVIATIONS FROM NORM ARE ', 4I5)
000251      PRINT 55, IZ2, IZ4, IZ6, IZ8
000252      55      FORMAT(2X, 'FIXED VALUES IN ZONES ARE ', 4I5)
000253      C      PUNCH CARDS FOR COMMANDERS
000254      C      ASSIGN COMMANDER LOCATIONS CLOSEST TO THE AVERAGE HOMINGS
000255      CALL SORT(IZON2, IZ2, 1)
000256      CALL SORT(IZON4, IZ4, 2)
000257      CALL SORT(IZON6, IZ6, 3)
000258      CALL SORT(IZON8, IZ8, 4)
000259      3000      FORMAT (2X, I3, 2X, 2A6, 5X, 2F10.2)
000260      PRINT 3001
000261      3001      FORMAT('0', 20X, 'ZONE 2 - BEFORE ADJUSTING')
000262      DO 3002 I = 1, IZ2
000263      CALL PRECRD (I, IZON2)
000264      PRINT 3000, I, NCOM, NSCRIB, AVX(L), AVY(L)
000265      3002      CONTINUE
000266      PRINT 3003
000267      3003      FORMAT('0', 20X, 'ZONE 4 - BEFORE ADJUSTING')
000268      DO 3004 I = 1, IZ4
000269      CALL PRECRD (I, IZON4)
000270      PRINT 3000, I, NCOM, NSCRIB, AVX(L), AVY(L)
000271      3004      CONTINUE
000272      PRINT 3005
000273      3005      FORMAT('0', 20X, 'ZONE 6 - BEFORE ADJUSTING')
000274      DO 3006 I = 1, IZ6
000275      CALL PRECRD (I, IZON6)
000276      PRINT 3000, I, NCOM, NSCRIB, AVX(L), AVY(L)
000277      3006      CONTINUE
000278      PRINT 3007
000279      3007      FORMAT('0', 20X, 'ZONE 8 - BEFORE ADJUSTING')
000280      DO 3008 I = 1, IZ8
000281      CALL PRECRD (I, IZON8)
000282      PRINT 3000, I, NCOM, NSCRIB, AVX(L), AVY(L)
000283      3008      CONTINUE
000284      CALL PULCOM(IZON2, ITEMP2, IZ2, IPT2)
000285      CALL PULCOM(IZON4, ITEMP4, IZ4, IPT4)
000286      CALL PULCOM(IZON6, ITEMP6, IZ6, IPT6)
000287      CALL PULCOM(IZON8, ITEMP8, IZ8, IPT8)
000288      C      LEFT BORDER
000289      WRITE(IOUT, 400)
000290      WRITE(IOUT, 401)
000291      C      WRITE(3, 318) IPT2
000292      LEAD = 1
000293      422      ICNT = 0
000294      L = ITEMP2(LEAD)
000295      TAVY = AVY(L)
000296      C      LOOK FOR THE CLOSEST ASSIGNMENT TO COMMANDER
000297      DO 413 I=1,IYL
000298      J = I
000299      IF(YLEFT(I) - TAVY) 413, 415, 416
000300      416      IF(J=1) 415, 415, 417
000301      417      IF((YLEFT(I) - TAVY) - (TAVY - YLEFT(I-1))) 415, 415, 418

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000302      418 J = I-1
000303      GO TO 415
000304      413 CONTINUE
000305      415 IF(J.EQ.1 .OR. J.EQ.IYL) GO TO 419
000306      IF(LEAD .GE. IPT2) GO TO 419
000307      C      LOOK FOR A COMMANDER WITH A DUPLICATE AVERAGE Y COORDINATE.
000308      K = ITEMP2(LEAD + 1)
000309      IF(TAVY - AVY(K)) 419, 420, 419
000310      420 ICNT = 1
000311      J = J-1
000312      419 CALL PRECRD (LEAD, ITEMP2)
000313      C      WRITE(3,223) NCOM, NSCRIB, XLEFT, YLEFT(J), IPT
000314      C      WRITE(3,318) (IHOM(I), I=1,IPT)
000315      WRITE(IOUT,402) LEAD,NCOM,NSCRIB,XLEFT,YLEFT(J),AVX(L),AVY(L),
000316      1 (IHOM(I), I=1,IPT)
000317      YLEFT(J) = 0
000318      LEAD = LEAD + 1
000319      IF(ICNT .EQ. 0) GO TO 421
000320      ICNT = 0
000321      J = J+2
000322      GO TO 419
000323      421 CALL PUSHUP(YLEFT,IYL)
000324      IF(LEAD .LE. IPT2) GO TO 422
000325      C      TOP BORDER
000326      WRITE(IOUT, 403)
000327      WRITE(IOUT, 401)
000328      C      WRITE(3, 318) IPT4
000329      LEAD = 1
000330      432 ICNT = 0
000331      L = ITEMP4(LEAD)
000332      TAVX = AVX(L)
000333      C      LOOK FOR THE CLOSEST ASSIGNMENT TO COMMANDER
000334      DO 423 I=1,IXT
000335      J = I
000336      IF(XTOP(I) - TAVX) 423, 425, 426
000337      426 IF(J-1) 425, 425, 427
000338      427 IF((XTOP(I) - TAVX) - (TAVX - XTOP(I-1))) 425, 425, 428
000339      428 J = J-1
000340      GO TO 425
000341      423 CONTINUE
000342      425 IF(J.EQ.1 .OR. J.EQ.IXT) GO TO 429
000343      IF(LEAD .GE. IPT4) GO TO 429
000344      C      LOOK FOR A COMMANDER WITH A DUPLICATE AVERAGE X COORDINATE.
000345      K = ITEMP4 (LEAD+1)
000346      IF(TAVX - AVX(K)) 429, 430, 429
000347      430 ICNT = 1
000348      J = J-1
000349      429 CALL PRECRD (LEAD, ITEMP4)
000350      C      WRITE(3,223) NCOM,NSCRIB,XTOP(J),YTOP,IPT
000351      C      WRITE(3,318) (IHOM(I), I=1,IPT)
000352      WRITE(IOUT,402) LEAD,NCOM,NSCRIB,XTOP(J),YTOP,AVX(L),AVY(L),
000353      1 (IHOM(I), I=1,IPT)
000354      XTOP(J) = 0
000355      LEAD = LEAD + 1
000356      IF(ICNT .EQ. 0) GO TO 431
000357      ICNT = 0
000358      J = J+2
000359      GO TO 429
000360      431 CALL PUSHUP (XTOP, IXT)
000361      IF(LEAD .LE. IPT4) GO TO 432
000362      C      RIGHT BORDER
000363      WRITE(IOUT, 404)
000364      WRITE(IOUT, 401)
000365      C      WRITE(3, 318) IPT6
000366      LEAD = 1
000367      442 ICNT = 0
000368      L = ITEMP6 (LEAD)
000369      TAVY = AVY(L)
000370      C      LOOK FOR THE CLOSEST ASSIGNMENT TO COMMANDER.
000371      DO 433 I=1,IYP
000372      J = I
000373      IF(YRITE(I) - TAVY) 436, 435, 433
000374      436 IF(J-1) 435, 435, 437
000375      437 IF((YRITE(I-1) - TAVY) - (TAVY-YRITE(I))) 435, 435, 435
000376      438 J = J-1
000377      GO TO 435
000378      433 CONTINUE
000379      435 IF(J.EQ.1 .OR. J.EQ.IYP) GO TO 439
000380      IF(LEAD .GE. IPT6) GO TO 439
000381      C      LOOK FOR A COMMANDER WITH A DUPLICATE AVERAGE Y COORDINATE.
000382      K = ITEMP6(LEAD + 1)
000383      IF(TAVY - AVY(K)) 439, 440, 439
000384      440 ICNT = 1
000385      J = J-1
000386      439 CALL PRECRD(LEAD,ITEMP6)
000387      C      WRITE(3,223) NCOM,NSCRIB,XRITE,YRITE(J),IPT

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000388 C WRITE(3,318) (IHOM(I), I=1,IPT)
000389 WRITE(IOUT,402) LEAD,NCOM,NSCRIB,XRITE,YRITE(J),AVX(L),AVY(L),
000390 1 (IHOM(I), I=1,IPT)
000391 YRITE(J) = 0
000392 LEAD = LEAD + 1
000393 IF(ICNT.EQ. 0) GO TO 441
000394 ICNT = 0
000395 J = J+2
000396 GO TO 439
000397 441 CALL PUSHUP(YRITE,IY)
000398 IF(LEAD.LE. IPT6) GO TO 442
000399 C BOTTOM BORDER
000400 WRITE(IOUT, 405)
000401 WRITE(IOUT, 401)
000402 C WRITE (3, 318) IPT8

000403 LEAD = 1
000404 452 ICNT = 0
000405 L = ITEMP8 (LEAD)
000406 TAVX = AVX(L)
000407 C LOOK FOR THE CLOSEST ASSIGNMENT TO COMMANDER
000408 DO 443 I=1,IXB
000409 J = I
000410 IF(XROTOM(I) - TAVX) 446, 445, 443
000411 446 IF(J=1) 445, 445, 447
000412 447 IF((YROTOM(I-1) - TAVY) - (TAVX-XROTOM(I))) 448, 445, 445
000413 448 J=J-1
000414 GO TO 445
000415 443 CONTINUE
000416 445 IF(J.EQ.1 .OR. J.EQ.IXB) GO TO 449
000417 IF(LEAD.GE. IPT8) GO TO 449
000418 C LOOK FOR A COMMANDER WITH A DUPLICATE AVERAGE X COORDINATE.
000419 K = ITEMP8(LEAD+1)
000420 IF(TAVX - AVX(K)) 449, 450, 449
000421 450 ICNT = 1
000422 J = J-1
000423 449 CALL PRECRD (LEAD, ITEMP8)
000424 C WRITE(3, 223) NCOM,NSCRIB,XBOTOM(J),YROTOM,IPT
000425 C WRITE(3, 318) (IHOM(I), I=1,IPT)
000426 WRITE(IOUT,402) LEAD,NCOM,NSCRIB,XROTOM(J),YROTOM,AVX(L),AVY(L),
000427 1 (IHOM(I), I=1,IPT)
000428 YROTOM(J) = 0
000429 LEAD = LEAD + 1
000430 IF(ICNT.EQ. 0) GO TO 451
000431 ICNT = 0
000432 J = J+2
000433 GO TO 449
000434 451 CALL PUSHUP (XBOTOM, IXB)
000435 IF(LEAD.LE. IPT8) GO TO 452
000436 IF(IDEV2.EQ. 0 .AND. IDEV4.EQ. 0 .AND. IDEV6.EQ. 0 .AND. IDEVA
000437 1 .EQ. 0) GO TO 200
000438 C ROTATE AROUND CORNERS FOR NORMALIZING DISTRIBUTION OF SUBSCRIBERS.
000439 250 FORMAT(2X, 'START ROTATING CLOCKWISE'/(4(2X, I4)))
000440 C *****
000441 C THIS SECTION IS PRESENTLY INTERACTIVE CAN BE PROGRAMMED TO BE AUTOMATIC.
000442 C *****
000443 J = 34
000444 CALL ROTATE(IZON8,IZ8,IZON2,I22,J,4)
000445 IDEV8 = IDEV8 - J
000446 IDEV2 = IDEV2 + J
000447 J = 14
000448 CALL ROTATE(IZON4,IZ4,IZON2,I72,J,4)
000449 IDEV4 = IDEV4 - J
000450 IDEV2 = IDEV2 + J
000451 J = 14
000452 CALL ROTATE(IZON8,IZ8,IZON6,I76,J,2)
000453 IDEV8 = IDEV8 - J
000454 IDEV6 = IDEV6 + J
000455 J = 8
000456 CALL ROTATE(IZON6,IZ6,IZON4,I74,J,1)
000457 IDEV6 = IDEV6 - J
000458 IDEV4 = IDEV4 + J
000459 GO TO 205
000460 C *****
000461 IF(IDEV2.LE. 0 .OR. IDEV4.GE. 0) GO TO 101
000462 J = IDEV4 * (-1)
000463 IF(IDEV2.LT. J) J = IDEV2
000464 CALL ROTATE(IZON2, I72, IZON4, I74, J, 1)
000465 IDEV2 = IDEV2 - J
000466 IDEV4 = IDEV4 + J
000467 101 IF(IDEV4.LE. 0 .OR. IDEV6.GE. 0) GO TO 102
000468 J = IDEV6 * (-1)
000469 IF(IDEV4.LT. J) J=IDEV4
000470 CALL ROTATE (IZON4, IZ4, IZON6, IZ6, J, 2)
000471 IDEV4 = IDEV4 - J
000472 IDEV6 = IDEV6 + J
000473 102 IF(IDEV6.LE. 0 .OR. IDEV8.GE. 0) GO TO 103

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000474      J = IDEV4 + (-1)
000475      IF(IDEV4 .LT. 0) J=IDEV6
000476      CALL ROTATE(IZON6, I76, IZON8, I78, J, 3)
000477      IDEV5 = IDEV5 - J
000478      IDEV8 = IDEV8 + J
000479  103 IF(IDEV2 .LE. 0 .OR. IDEV2 .GE. 0) GO TO 104
000480      J = IDEV2 + (-1)
000481      IF(IDEV4 .LT. 0) J=IDEV8
000482      CALL ROTATE(IZON8, I78, IZON2, I72, J, 4)
000483      IDEV3 = IDEV3 - J
000484      IDEV2 = IDEV2 + J
000485  104 IF(IDEV2 .EQ. 0 .AND. IDEV4 .EQ. 0 .AND. IDEV6 .EQ. 0 .AND. IDEV8
000486      1 .EQ. 0) GO TO 200
000487      PRINT 116, IDEV2, IDEV4, IDEV6, IDEV8
000488  116 FORMAT(2X, 'ROTATE SUBSCRIBERS COUNTERCLOCKWISE.
000489      ROTATE SUBSCRIBERS COUNTERCLOCKWISE.
000490      IF(IDEV2 .LE. 0 .OR. IDEV8 .GE. 0) GO TO 105
000491      J = IDEV3 + (-1)
000492      IF(IDEV2 .LT. 0) J=IDEV2
000493      CALL ROTATE(IZON2, I72, IZON6, I76, J, 3)
000494      IDEV2 = IDEV2 - J
000495      IDEV3 = IDEV3 + J
000496  105 IF(IDEV4 .LE. 0 .OR. IDEV6 .GE. 0) GO TO 106
000497      J = IDEV6 + (-1)
000498      IF(IDEV4 .LT. 0) J=IDEV8
000499      CALL ROTATE(IZON6, I76, IZON4, I74, J, 2)
000500      IDEV8 = IDEV8 - J
000501      IDEV6 = IDEV6 + J
000502  106 IF(IDEV6 .LE. 0 .OR. IDEV4 .GE. 0) GO TO 107
000503      J = IDEV4 + (-1)
000504      IF(IDEV6 .LT. 0) J=IDEV6
000505      CALL ROTATE(IZON6, I76, IZON4, I74, J, 1)
000506      IDEV6 = IDEV6 - J
000507      IDEV4 = IDEV4 + J
000508  107 IF(IDEV4 .LE. 0 .OR. IDEV2 .GE. 0) GO TO 108
000509      J = IDEV2 + (-1)
000510      IF(IDEV4 .LT. 0) J=IDEV4
000511      CALL ROTATE(IZON4, I74, IZON2, I72, J, 4)
000512      IDEV4 = IDEV4 - J
000513      IDEV2 = IDEV2 + J
000514  108 IF(IDEV2 .EQ. 0 .AND. IDEV4 .EQ. 0 .AND. IDEV6 .EQ. 0 .AND. IDEV8 .EQ. 0) GO TO
000515      1 200
000516  C      LAST ADJUSTMENT BEGINS
000517      PRINT 109, IDEV2, IDEV4, IDEV6, IDEV8
000518  109 FORMAT(2X, 'LAST ROTATION BEGINS'/(4(2X, I4)))
000519      IF(IDEV2 .GT. 0 .AND. IDEV6 .LT. 0) GO TO 110
000520      IF(IDEV4 .GT. 0 .AND. IDEV8 .LT. 0) GO TO 111
000521      IF(IDEV6 .GT. 0 .AND. IDEV2 .LT. 0) GO TO 112
000522      IF(IDEV8 .GT. 0 .AND. IDEV4 .LT. 0) GO TO 113
000523  205 IF(IDEV2 .EQ. 0 .AND. IDEV4 .EQ. 0 .AND. IDEV6 .EQ. 0 .AND.
000524      1 IDEV8 .EQ. 0) GO TO 200
000525  218 PRINT 117, I72, IY1, I74, IY1, I76, IYR, IZ0, IY8, NPS
000526  117 FORMAT(2X, 'ERROR = ALL DEVIATIONS SHOULD = 0', 9I6)
000527      STOP
000528  110 IF((IDEV2 + IDEV6) .NE. 0) GO TO 218
000529      J = IDEV2 / 2
000530      IF(J .EQ. 0) GO TO 120
000531      CALL ROTATE(IZON2, I72, IZON4, I74, J, 1)
000532      IDEV2 = IDEV2 - J
000533      IDEV4 = IDEV4 + J
000534      CALL ROTATE(IZON4, I74, IZON6, I76, J, 2)
000535      IDEV4 = IDEV4 - J
000536      IDEV6 = IDEV6 + J
000537  120 J = IDEV2
000538      CALL ROTATE(IZON2, I72, IZON8, I78, J, 3)
000539      IDEV2 = IDEV2 - J
000540      IDEV8 = IDEV8 + J
000541      CALL ROTATE(IZON8, I78, IZON6, I76, J, 2)
000542      IDEV8 = IDEV8 - J
000543      IDEV6 = IDEV6 + J
000544      GO TO 205
000545  111 IF((IDEV4 + IDEV8) .NE. 0) GO TO 218
000546      J = IDEV4 / 2
000547      IF(J .EQ. 0) GO TO 121
000548      CALL ROTATE(IZON4, I74, IZON6, I76, J, 2)
000549      IDEV4 = IDEV4 - J
000550      IDEV6 = IDEV6 + J
000551      CALL ROTATE(IZON6, I76, IZON2, I72, J, 3)
000552      IDEV6 = IDEV6 - J
000553      IDEV2 = IDEV2 + J
000554  121 J = IDEV4
000555      CALL ROTATE(IZON4, I74, IZON2, I72, J, 4)
000556      IDEV4 = IDEV4 - J
000557      IDEV2 = IDEV2 + J
000558      CALL ROTATE(IZON2, I72, IZON6, I76, J, 3)
000559      IDEV2 = IDEV2 - J

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000560 IDEV8 = IDEV8 + J
000561 GO TO 205
000562 112 IF((IDEV6 + IDEV2) .NE. 0) GO TO 218
000563 J = IDEV6 / 2
000564 IF(J .EQ. 0) GO TO 122
000565 CALL ROTATE(IZON6, I76, IZON8, I78, J, 3)
000566 IDEV6 = IDEV6 - J
000567 IDEV8 = IDEV8 + J
000568 CALL ROTATE(IZON8, I78, IZON2, I72, J, 4)
000569 IDEV8 = IDEV8 - J
000570 IDEV2 = IDEV2 + J
000571 122 J = IDEV6
000572 CALL ROTATE(IZON6, I76, IZON4, I74, J, 1)
000573 IDEV6 = IDEV6 - J
000574 IDEV4 = IDEV4 + J
000575 CALL ROTATE(IZON4, I74, IZON2, I72, J, 4)
000576 IDEV4 = IDEV4 - J
000577 IDEV2 = IDEV2 + J
000578 GO TO 205
000579 113 IF((IDEV8 + IDEV4) .NE. 0) GO TO 219
000580 J = IDEV8 / 2
000581 IF(J .EQ. 0) GO TO 123
000582 CALL ROTATE(IZON8, I78, IZON2, I72, J, 4)
000583 IDEV8 = IDEV8 - J
000584 IDEV2 = IDEV2 + J
000585 CALL ROTATE(IZON2, I72, IZON4, I74, J, 1)
000586 IDEV2 = IDEV2 - J
000587 IDEV4 = IDEV4 + J
000588 123 J = IDEV8
000589 CALL ROTATE(IZON8, I78, IZON6, I76, J, 2)
000590 IDEV8 = IDEV8 - J
000591 IDEV6 = IDEV6 + J
000592 CALL ROTATE(IZON6, I76, IZON4, I74, J, 1)
000593 IDEV6 = IDEV6 - J
000594 IDEV4 = IDEV4 + J
000595 GO TO 205
000596 C SORT ALL ZONES FOR PRINTOUT
000597 200 CALL SORT(IZON2, I72, 1)
000598 CALL SORT(IZON4, I74, 2)
000599 CALL SORT(IZON6, I76, 3)
000600 CALL SORT(IZON8, I78, 4)
000601 C FIND THE COMMANDERS TO BE PLOTTED ON THIS CHART.
000602 C THERE WILL BE AT MOST 5 COMMANDERS AND THEIR SUBORDINATES ON A CHART.
000603 NOSP8 = 5
000604 NCM8 = NAMEPT
000605 IFND = 0
000606 ICHART = 0
000607 C FIND THE NO. OF CHARTS.
000608 NCHRT = NCM8 / NOSP8
000609 IREND = NCM8 - NOSP8 * NCHRT
000610 IF(IREND .NE. 0) NCHRT = NCHRT + 1
000611 C FIND THE NO. OF SUBSCRIBERS PER CHART
000612 NOSP8 = NCM8 / NCHRT
000613 IREND = NCM8 - NOSP8 * NCHRT
000614 460 ICHART = ICHART + 1
000615 IF(ICHART .GT. NCHRT) RETURN
000616 IREGIN = IFND + 1
000617 IFND = IFND + NOSP8
000618 IF(ICHART .LE. IREND) IFND = IFND + 1
000619 IF(IFND .LE. NAMEPT) GO TO 457
000620 PRINT 456, NAMEPT, IFND
000621 456 FORMAT(2X, 'ERROR - NAMEPT = ', I3, 2X, 'IFND = ', I3)
000622 STOP
000623 C PUNCH CARDS FOR LEFT BORDER
000624 457 ICNT = 0
000625 WRITE(IOUT, 400)
000626 400 FORMAT(14I, 35X, '11LEFT BORDER//')
000627 WRITE(IOUT, 401)
000628 401 FORMAT(7X, 9HCOMMANDER, 2X, 11HSUBORDINATE, 8X, 8HX COORD., 7X,
000629 1 8HX COORD., 2X, 'AV. X', 1X, 'AV. Y', 8X, 7HMOVINGS//)
000630 318 FORMAT(5I5)
000631 DO 220 I=1,I72
000632 CALL PRECRD (I, IZON2)
000633 DO 458 K = IREGIN, IFND
000634 IF(NCOM .EQ. NAMECD (K)) GO TO 455
000635 458 CONTINUE
000636 GO TO 220
000637 455 CONTINUE
000638 ICNT = ICNT + 1
000639 C WRITE(3, 223) NCOM, NSCRIB, YLEFT, YLEFT(I), IPT
000640 223 FORMAT(2X, A3, 2X, A3, 25X, 2F10.5, 2X, I3)
000641 C WRITE(3, 318) (IHOM(J), J=1,IPT)
000642 WRITE(IOUT, 402) ICNT, NCOM, NSCRIB, XLEFT, YLEFT(I), AVX(L), AVY(L),
000643 1 (IHOM(J), J=1,IPT)
000644 402 FORMAT(2X, I3, 4X, A3, 9X, A3, 10X, F10.5, 6X, F10.5,
000645 1 2X, F5.2, 1X, F5.2, 5X, 5(I4, 2X))
000646 220 CONTINUE

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000647 C WRITE (3, 318) ICNT
000648 C PUNCH CARDS FOR TOP BORDER
000649 ICNT = 0
000650 WRITE (IOUT, 403)
000651 403 FORMAT(1H1, 36X, 10HTOP BORDER//)
000652 WRITE (IOUT, 401)
000653 DO 224 I=1, IZ4
000654 CALL PRECRD(I, IZON4)
000655 DO 501 K = IBEGIN, IEND
000656 IF(NCOM .EQ. NAMECD (K)) GO TO 502
000657 501 CONTINUE
000658 GO TO 224
000659 502 CONTINUE
000660 ICNT = ICNT + 1
000661 C WRITE(3, 223) NCOM, NSCRIB, XTOP(I), YTOP, IPT
000662 C WRITE(3, 318) (IHOM(J), J=1, IPT)
000663 WRITE(IOUT, 402) ICNT, NCOM, NSCRIB, XTOP(I), YTOP, AVX(L), AVY(L),
000664 1 (IHOM(J), J=1, IPT)
000665 224 CONTINUE
000666 C WRITE (3, 318) ICNT
000667 C PUNCH CARDS FOR RIGHT BORDER
000668 ICNT = 0
000669 WRITE (IOUT, 404)
000670 404 FORMAT(1H1, 35X, 12HRIGHT BORDER//)
000671 WRITE (IOUT, 401)
000672 DO 225 I=1, IZ6
000673 CALL PRECRD(I, IZON6)
000674 DO 503 K = IBEGIN, IEND
000675 IF(NCOM .EQ. NAMECD (K)) GO TO 504
000676 503 CONTINUE
000677 GO TO 225
000678 504 CONTINUE
000679 ICNT = ICNT + 1
000680 C WRITE(3, 223) NCOM, NSCRIB, XRITE, YRITE(I), IPT
000681 C WRITE(3, 318) (IHOM(J), J=1, IPT)
000682 WRITE(IOUT, 402) ICNT, NCOM, NSCRIB, XRITE, YRITE(I), AVX(L), AVY(L),
000683 1 (IHOM(J), J=1, IPT)
000684 225 CONTINUE
000685 C WRITE (3, 318) ICNT
000686 C PUNCH CARDS FOR BOTTOM BORDER
000687 ICNT = 0
000688 405 FORMAT(1H1, 34X, 13HBOTTOM BORDER//)
000689 WRITE (IOUT, 405)
000690 WRITE (IOUT, 401)
000691 DO 226 I=1, IZ8
000692 CALL PRECRD(I, IZON8)
000693 DO 505 K = IBEGIN, IEND
000694 IF(NCOM .EQ. NAMECD (K)) GO TO 506
000695 505 CONTINUE
000696 GO TO 226
000697 506 CONTINUE
000698 ICNT = ICNT + 1
000699 C WRITE(3, 223) NCOM, NSCRIB, XBTOM(I), YBTOM, IPT
000700 C WRITE(3, 318) (IHOM(J), J=1, IPT)
000701 WRITE(IOUT, 402) ICNT, NCOM, NSCRIB, XBTOM(I), YBTOM, AVX(L), AVY(L),
000702 1 (IHOM(J), J=1, IPT)
000703 226 CONTINUE
000704 C WRITE (3, 318) ICNT
000705 GO TO 460
000706 END

```

```

000001 SUBROUTINE PRECRD(I, IZON)
000002 COMMON /CMDR/ ICOM(500), ISUB(500), IHOME1(500), IHOME2(500), NS
000003 COMMON /ECON/ IPSUB(500), AVX(500), AVY(500), IZON2(500), IZON4(500),
000004 1 IZON6(500), IZON8(500),
000005 2 IHOM(5), YLEFT(200), XTOP(200), YRITE(200),
000006 3 XBTOM(200), IPT, NCOM, NSCRIB, IBLANK, IOUT, L
000007 DIMENSION IZON(200)
000008 L = IZON(I)
000009 LL = IPSUB(LL)
000010 NCOM = ICOM(LL)
000011 NSCRIB = ISUB(LL)
000012 IPT = 0
000013 121 IPT = IPT + 1
000014 IHOM(IPT) = IHOME1(LL)
000015 IF(IHOME2(LL) .EQ. -1) RETURN
000016 IPT = IPT + 1
000017 IHOM(IPT) = IHOME2(LL)
000018 LL = LL + 1
000019 IF(ICOM(LL) .EQ. NCOM .AND. ISUB(LL) .EQ. NSCRIB) GO TO 121
000020 RETURN
000021 END

```

```

000001      SUBROUTINE ROTATE(IFROM, IPFR, ITO, IPTO, NO, IFLAG)
000002      DIMENSION IFROM(10), ITO(10)
000003      CALL SORT(IFROM, IPFR, IFLAG)
000004      DO 1 I=1,NO
000005          IPTO = IPTO + 1 +
000006          ITO(IPTO) = IFROM(IPFR)
000007      1 IPFR = IPFR - 1
000008      RETURN
000009      END

```

```

000001      SUBROUTINE SORT(IARRAY, IPTA, IFLAG)
000002      COMMON /FCON/ IPSUB(500),AVX(500),AVY(500)
000003      DIMENSION IARRAY(IPTA)
000004      C      SORT IS DEPENDENT ON IFLAG
000005      C      IF IFLAG = 1 - ASCENDING Y, ASCENDING X
000006      C      IF IFLAG = 2 - ASCENDING X, ASCENDING Y
000007      C      IF IFLAG = 3 - DESCENDING Y, DESCENDING X
000008      C      IF IFLAG = 4 - DESCENDING X, DESCENDING Y
000009      J = IPTA - 1
000010      IF (J .LE. 0) RETURN
000011      DO 1 I=1,J
000012          IP = IARRAY(I)
000013          TAVX = AVX(IP)
000014          TAVY = AVY(IP)
000015          K = I+1
000016          DO 2 L=K,IPTA
000017              IPP = IARRAY(L)
000018              IF (IFLAG .NE. 1) GO TO 10
000019              IF (AVY(IPP) - TAVY) 3, 4, 2
000020              4 IF (AVX(IPP) - TAVX) 3, 2, 2
000021              10 IF (IFLAG .NE. 2) GO TO 20
000022              IF (AVX(IPP) - TAVX) 3, 5, 2
000023              5 IF (AVY(IPP) - TAVY) 3, 2, 2
000024              20 IF (IFLAG .NE. 3) GO TO 30
000025              IF (AVY(IPP) - TAVY) 2, 6, 3
000026              6 IF (AVX(IPP) - TAVX) 2, 2, 3
000027              30 IF (IFLAG .EQ. 4) GO TO 31
000028              PRINT 32
000029              32 FORMAT(2X, 'ERROR IN FLAG TO SORT ROUTINE. VALUE MUST BE FROM 1-4.
000030              1 '/')
000031              STOP
000032              31 IF (AVX(IPP) - TAVX) 2, 7, 3
000033              7 IF (AVY(IPP) - TAVY) 2, 2, 3
000034              3 TAVX = AVX(IPP)
000035              TAVY = AVY(IPP)
000036              IARRAY(L) = IP
000037              IP = IPP
000038              2 CONTINUE
000039              IARRAY(I) = IP
000040              1 CONTINUE
000041              RETURN
000042      END

```

```

000001      SUBROUTINE PULCOM (IZON, ITEMP, IPZ, ITT)
000002      COMMON /CMDR/ ICOM(500),ISUB(500),IHOME1(500),IHOME2(500), NS
000003      COMMON /FCON/ IPSUB(500),AVX(500),AVY(500),IZON2(500),IZON4(500),
000004      1 IZON6(500),IZON8(500),
000005      2 IHOM(5), YLEFT(200), XTOP(200), YRITE(200),
000006      3 XBOTTOM(200), IPT, NCOM, /ISCRIP, IBLANK, IOUT,L
000007      DIMENSION IZON(10), ITEMP(10)
000008      DATA/IBLANK/ 6H
000009      ITT = 0
000010      DO 1 I=1,IPZ
000011          L = IZON(I)
000012          LL = IPSUB(L)
000013          IF (ISUB(LL) .NE. IBLANK) GO TO 1
000014          ITT = ITT + 1
000015          ITEMP(ITT) = L
000016          IZON(I) = 0
000017      1 CONTINUE
000018      CALL PUSHUP (IZON, IPZ)
000019      RETURN
000020      END

```

000001	SUBROUTINE PUSHUP (IZON, IPZ)
000002	DIMENSION IZON(10)
000003	ICNT = 0
000004	DO 1 I=1,IPZ
000005	IF(IZON(I)) 3, 2, 3
000006	2 ICNT = ICNT + 1
000007	GO TO 1
000008	3 IF(ICNT) 1, 1, 4
000009	4 IZON (I - ICNT) = IZON(I)
000010	1 CONTINUE
000011	IPZ = IPZ - ICNT
000012	RETURN
000013	END

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBS TN-829	2. Gov't Accession No.	3. Recipient's Accession No.
TITLE AND SUBTITLE <i>Multicommodity Network Plotting via Program NETPLT</i>			5. Publication Date June 1974
			6. Performing Organization Code 640.01
AUTHOR(S) <i>Zella G. Ruthberg, Gloria R. Bolotsky, William Slater, Jr.</i>			8. Performing Organ. Report No.
PERFORMING ORGANIZATION NAME AND ADDRESS NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, D.C. 20234			10. Project/Task/Work Unit No. 640.2456
			11. Contract/Grant No. RO 72-78
Sponsoring Organization Name and Complete Address (Street, City, State, ZIP) <i>Defense Communications Agency</i>			13. Type of Report & Period Covered Final
			14. Sponsoring Agency Code

SUPPLEMENTARY NOTES

Library of Congress Catalog Card Number: 74-600074

ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

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KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)

Communication network; multicommodity network; network; network display; plotting algorithm; plotting program.

AVAILABILITY For Official Distribution. Do Not Release to NTIS	<input checked="" type="checkbox"/> Unlimited	19. SECURITY CLASS (THIS REPORT) UNCLASSIFIED	21. NO. OF PAGES 67
Order From Sup. of Doc., U.S. Government Printing Office Washington, D.C. 20402, SD Cat. No. C13 .46:829		20. SECURITY CLASS (THIS PAGE) UNCLASSIFIED	22. Price \$1.10
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